CHAPTER 17

Orbit

Introduction

Applied anatomy

The orbit is a pear-shaped cavity, the stalk of which is the optic canal (Fig. 17.1). The intraorbital portion of the optic nerve is longer (25 mm) than the distance between the back of the globe and the optic canal (18 mm). This allows for significant forward displacement of the globe (proptosis) without excessive stretching of the optic nerve.

1. **The roof** consists of *two* bones: lesser wing of the sphenoid and the orbital plate of the frontal. It is located subjacent to the anterior cranial fossa and frontal sinus. A defect in the orbital roof may cause pulsatile proptosis as a result of transmission of cerebrospinal fluid pulsation to the orbit.
2. **The lateral wall** also consists of *two* bones: greater wing of the sphenoid and zygomatic. The anterior half of the globe is vulnerable to lateral trauma since it protrudes beyond the lateral orbital margin.
3. **The floor** consists of *three* bones: zygomatic, maxillary and palatine. The posteromedial portion of the maxillary bone is relatively weak and may be involved in a 'blow-out' fracture. The orbital floor also forms the roof of the maxillary sinus, so that maxillary carcinoma invading the orbit may displace the globe upwards.
4. **The medial wall** consists of *four* bones: maxillary, lacrimal, ethmoid and sphenoid. The lamina papyracea, which forms part of the medial wall, is paper-thin and perforated by numerous foramina for nerves and blood vessels. Orbital cellulitis is therefore frequently secondary to ethmoidal sinusitis.
5. **The superior orbital fissure** is a slit between the greater and lesser wings of the sphenoid bone through which pass important structures from the cranium to the orbit.
   - The superior portion contains the lacrimal, frontal and trochlear nerves and the superior ophthalmic vein.
   - The inferior portion contains the superior and inferior divisions of the oculomotor nerve, the abducens, the nasociliary and sympathetic fibres.

NB: Inflammation at the superior orbital fissure and orbital apex may therefore result in a multitude of signs including ophthalmoplegia and venous outflow obstruction resulting in oedema of the lids and proptosis.

Clinical signs of orbital disease

Soft tissue involvement

1. **Signs** include lid and periorbital oedema, ptosis, chemosis and conjunctival injection (Fig. 17.2).
2. **Causes** include thyroid eye disease, orbital cellulitis, inflammatory orbital disease and arteriovenous shunts.



Fig. 17.2
Soft tissue involvement in orbital disease

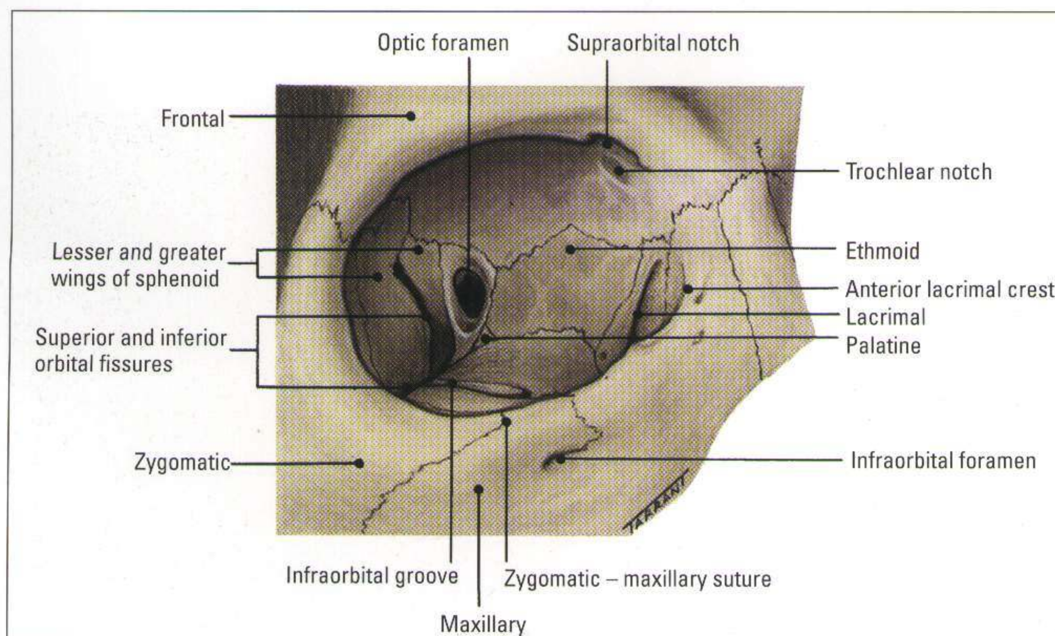


Fig. 17.1
Anatomy of the orbit

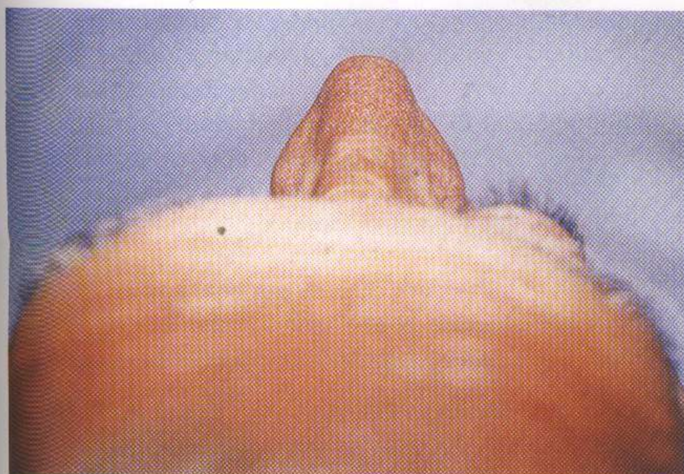


Fig. 17.3
Proptosis

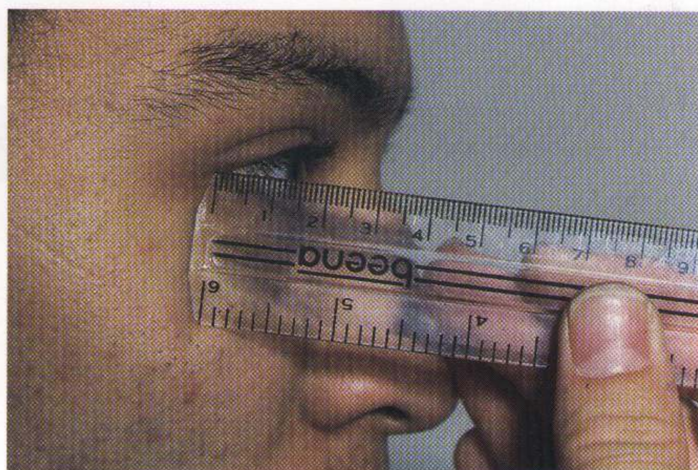


Fig. 17.4
Measurement of globe protrusion with a plastic rule

Proptosis

This is an abnormal protrusion of the globe which may be caused by retrobulbar lesions or, less frequently, a shallow orbit. Asymmetrical proptosis is best detected by looking down at the patient from above and behind (Fig. 17.3). The following characteristics are relevant:

1. **The direction of proptosis** may indicate the possible pathology. For example, space-occupying lesions within the muscle cone, such as cavernous haemangiomas and optic nerve tumours, cause axial proptosis, whereas extraconal lesions usually give rise to eccentric proptosis, the direction of which is governed by the site of the mass.
2. **The severity of proptosis** can be measured with a plastic rule resting on the lateral orbital margin (Fig. 17.4) or a Hertel exophthalmometer, by means of which the corneal apices are visualized in the mirrors and the degree of ocular protrusion is read off a scale (Fig. 17.5). Ideally, measurements should be taken in both erect and supine positions. Readings greater than 20 mm are indicative of proptosis and a difference of 2 mm between the two eyes is suspicious regardless of the absolute value. Proptosis is graded as mild (21–23 mm), moderate (24–27 mm) and severe (28 mm or more). The dimensions of the palpebral apertures and any lagophthalmos should also be noted.
3. **Pseudo-proptosis** (false impression of proptosis) may be due to facial asymmetry, severe ipsilateral enlargement of the globe (e.g. high myopia or buphthalmos) (Fig. 17.6), ipsilateral lid retraction or contralateral enophthalmos (Fig. 17.7).

Dystopia

This implies displacement of the globe in the coronal plane, usually due to an extraconal orbital mass such as a lacrimal gland tumour (Fig. 17.8). It may coexist with proptosis or enophthalmos. Horizontal displacement is measured from



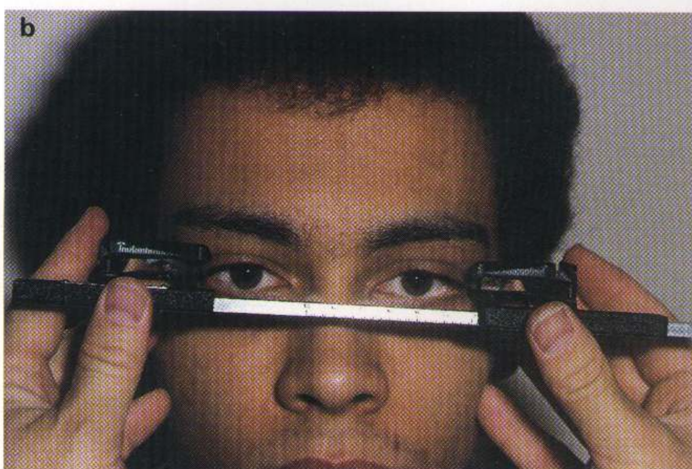


Fig. 17.5
Measurement of globe protrusion with a Hertel exophthalmometer



Fig. 17.6
Right pseudo-proptosis due to a combination of a large globe associated with very high myopia and phthisis of the left eye



Fig. 17.7
Mild left enophthalmos



Fig. 17.8
Left downward dystopia

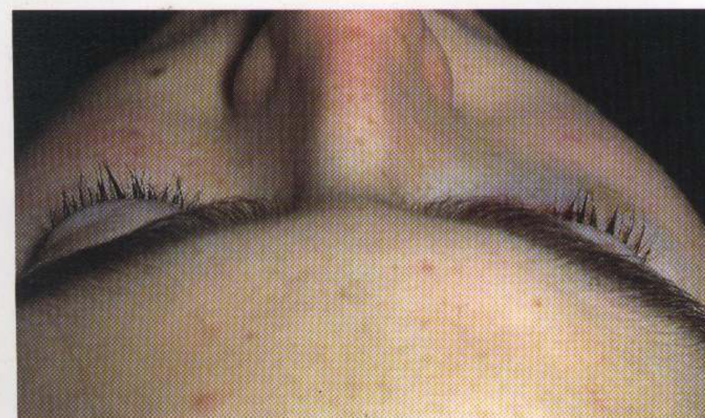


Fig. 17.9
Right enophthalmos due to an orbital floor blow-out fracture

the midline (nose) to the nasal limbus, while vertical dystopia is read off a vertical scale perpendicular to a horizontal rule placed over the bridge of the nose. In the context of coexistent strabismus, it is essential to establish that the eye is fixating, if necessary by occluding the fellow eye, while measuring dystopia.

Enophthalmos

This implies recession of the globe within the orbit. Often subtle, it may be caused by the following mechanisms:

1. **Structural abnormalities** of the orbital walls may be post-traumatic, such as blow-out fractures of the orbital floor (Fig. 17.9), or congenital.
2. **Atrophy of orbital contents** may be secondary to radiotherapy, scleroderma or eye poking (oculodigital sign) in blind infants (*see* Fig. 15.33).
3. **Cicatrizing orbital lesions** such as metastatic schirrous carcinoma and chronic sclerosing inflammatory orbital disease.

> *NB:* Pseudo-enophthalmos may be caused by microphthalmos or phthisis bulbi.

Ophthalmoplegia

Defective ocular motility may be caused by one or more of the following:

1. **An orbital mass.**
2. **Restrictive myopathy** in thyroid eye disease or orbital myositis.
3. **Ocular motor nerve lesions** associated with carotid–cavernous fistula, Tolosa–Hunt syndrome and malignant lacrimal gland tumours.
4. **Tethering** of extraocular muscles or fascia in a blow-out fracture.
5. **Splinting** of the optic nerve by an optic nerve sheath meningioma.

Restrictive versus neurological ophthalmoplegia

The following tests may be used to differentiate a restrictive from a neurological motility defect:

1. **The forced duction test**
   a. Topical anaesthetic drops are instilled.
   b. A cotton pledget soaked in anaesthetic is inserted into both eyes over the muscles to be tested and left for about 5 minutes.
   c. The insertion of the muscle in the involved eye is grasped with forceps and the globe is rotated in the direction of limited mobility.
   d. The test is repeated in the unaffected eye.
      (i) *Positive result:* difficulty or inability to move the globe indicates a restrictive problem such as thyroid myopathy or muscle entrapment in an orbital floor frac-

ture. In the opposite eye, no such resistance will be encountered unless pathology is bilateral.

(ii) *Negative result:* no resistance will be encountered in either eye if the muscle is paretic as a result of a neurological lesion.

2. **The differential intraocular pressure test**
   a. The intraocular pressure is measured in the primary position of gaze.
   b. The measurement is repeated with the patient attempting to look into the direction of limited mobility.
      (i) *Positive result*: an increase of 6 mmHg or more denotes resistance transmitted to the globe by muscle restriction.
      (ii) *Negative result*: an increase of <6 mmHg suggests a neurological lesion.

> *NB:* The advantage of this test over the forced duction is less discomfort and an end-point that is objective rather than subjective.

3. **Saccadic eye movements** in neurological lesions are reduced in velocity, while restrictive defects manifest normal saccadic velocity with 'sudden halting' of ocular movement.

Causes of visual dysfunction

1. **Exposure keratopathy** secondary to severe proptosis, associated with lagophthalmos and impaired Bell phenomenon, is the most common.
2. **Compressive optic neuropathy** characterized by signs of optic nerve dysfunction such as impaired visual acuity, colour vision and contrast sensitivity, visual field defects, afferent conduction defects and optic disc changes (*see* Chapter 18).
3. **Choroidal folds** at the macula may occasionally affect vision.

Dynamic properties

The following dynamic features may give clues as to the probable pathology:

1. **Increasing venous pressure** by dependent head position, Valsalva manoeuvre or jugular compression may induce or exacerbate proptosis in patients with orbital venous anomalies or infants with capillary orbital haemangiomas.
2. **Pulsation** is caused either by an arteriovenous communication or a defect in the orbital roof.
   - In the latter the pulsation is transmitted from the brain by the cerebrospinal fluid and there is no associated bruit.
   - In the former pulsation may be associated with a bruit depending on the size of the communication.

> *NB:* Mild pulsation is best detected on the slit-lamp, particularly when performing applanation tonometry.

3. **A bruit** is a sign of carotid–cavernous fistula. It is best heard with the bell of the stethoscope and is lessened or abolished by gently compressing the ipsilateral carotid artery in the neck.

Optic disc changes

1. **Optic atrophy** (Fig. 17.10), which may be preceded by swelling, is a feature of severe compressive optic neuropathy. Important causes include thyroid eye disease and optic nerve tumours.
2. **Opticociliary shunts** consist of enlarged pre-existing parapapillary capillaries which shunt blood from the central retinal venous circulation to the parapapillary choroidal circulation when there is obstruction of the normal drainage channels (Fig. 17.11d). On ophthalmoscopy the vessels appear as large tortuous channels most

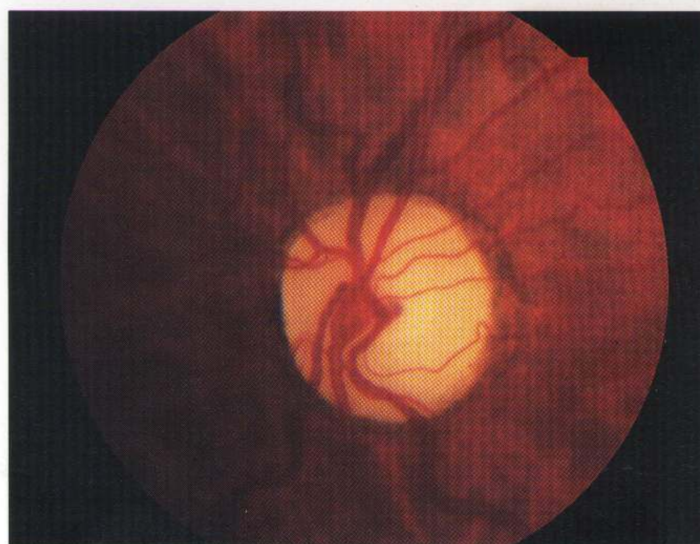


Fig. 17.10
Optic atrophy

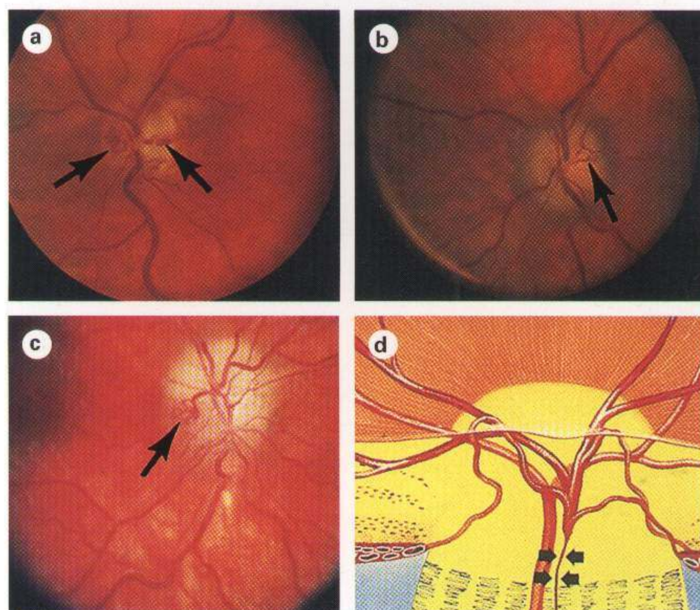


Fig. 17.11
Opticociliary shunts (*see text*) (Courtesy of Wilmer Institute)

frequently on the temporal side, which disappear at the disc margin (Fig. 17.11a–c). Although rare, they may be associated with any orbital or optic nerve tumour which compresses the intraorbital optic nerve and impairs blood flow through the central retinal vein. The most common tumour associated with shunts is the optic nerve sheath meningioma but may also occur with optic nerve gliomas and cavernous haemangiomas.

Choroidal folds

These are a series of roughly parallel alternating light and dark delicate lines or striae which are most frequently noted at the posterior pole (Fig. 17.12). Choroidal folds may occur in a wide variety of orbital lesions including tumours, dysthyroid ophthalmopathy, inflammatory conditions and mucoceles. The folds are usually asymptomatic and do not cause visual loss although some patients develop an increase in hypermetropia. Although choroidal folds tend to be more common with greater amounts of proptosis and anteriorly located tumours, in some cases their presence can precede the onset of clinically evident proptosis.

Retinal vascular changes

1. **Venous dilatation** and **tortuosity** characteristically occur in orbital arteriovenous communications.
2. **Venous dilatation** may also be associated with disc swelling in patients with an orbital mass.
3. **Vascular occlusions** may occur in carotid–cavernous fistulae, orbital cellulitis and optic nerve tumours.

Special investigations

1. **CT** is useful for depicting bony structures and the location and size of space-occupying lesions. It is of particular value in patients with orbital trauma because it can detect small fractures, foreign bodies, blood, herniation of extraocular muscle and emphysema. It is, however, unable to distinguish different pathological soft tissue masses which are radiologically isodense.
2. **MRI** can image orbital apex lesions and intracranial extension of orbital tumours. Serial short tau inversion recovery (STIR) scans are valuable in assessing inflammatory activity in thyroid eye disease.
3. **Plain radiographs** have diminished in importance since the advent of CT and MRI. The two main views are as follows:
   a. *The Caldwell*, taken with the patient's nose and forehead touching the film, is most useful in detecting orbital lesions (Fig. 17.13).
   b. *The Waters*, taken with the patient's chin slightly elevated, is best in detecting orbital floor fractures (Fig. 17.14).

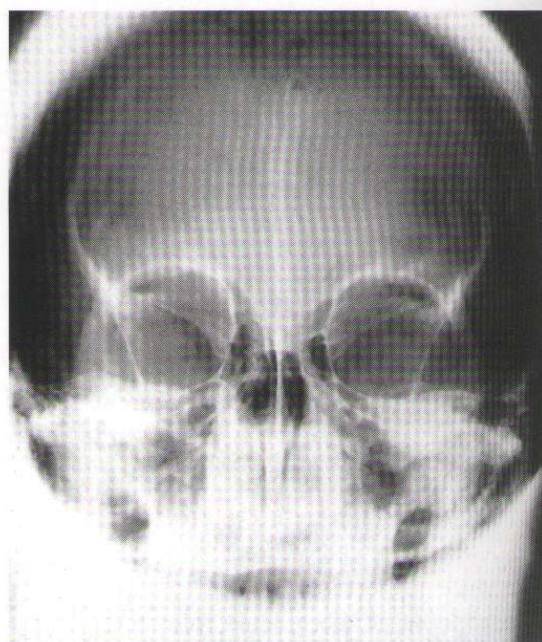


Fig. 17.13
Caldwell view

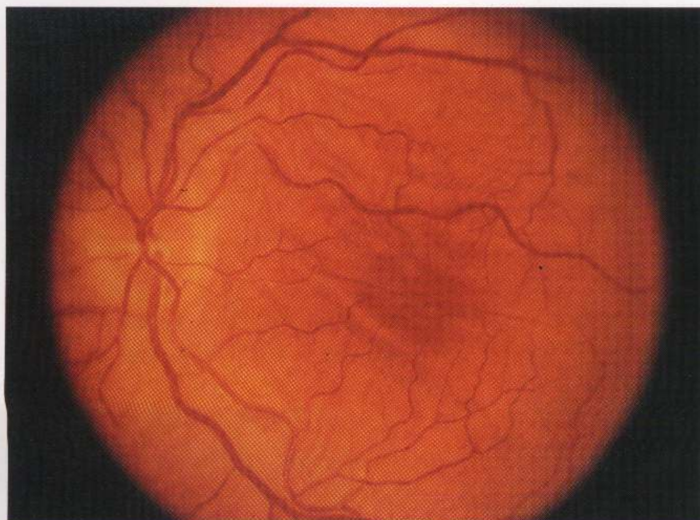


Fig. 17.12
Choroidal folds (Courtesy of C. Barry)

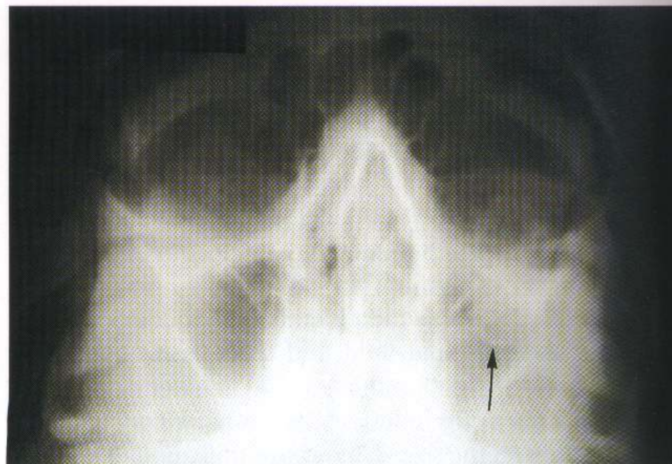


Fig. 17.14
Waters view showing herniation of orbital contents into the maxillary antrum through a blow-out fracture of the orbital floor (arrow)

4. **Fine-needle biopsy** is performed under CT guidance using a 23-gauge needle. This technique is particularly valuable in patients with suspected orbital metastases and in those with secondary orbital invasion by neoplasms from contiguous structures. Potential problems include haemorrhage and ocular penetration.

Thyroid eye disease

Introduction

Thyrotoxicosis

Thyrotoxicosis (Graves disease) is an autoimmune disorder which usually presents in the third to fourth decades of life and affects women more commonly than men (*see* Chapter 20). Thyroid eye disease (TED) may occur in the absence of clinical and biochemical evidence of thyroid dysfunction. More commonly, systemic features are present, but they may follow a different course from TED. The occurrence of signs of Graves disease in a patient who is not clinically hyperthyroid is referred to as euthyroid or ophthalmic Graves disease. This is the form most frequently presenting to ophthalmologists.

Pathogenesis

This involves an organ-specific autoimmune reaction in which a humoral agent (IgG antibody) produces the following changes:

1. **Inflammation of extraocular muscles** characterized by pleomorphic cellular infiltration (Fig. 17.15), associated with increased secretion of glycosaminoglycans and osmotic imbibition of water. The muscles become enlarged, sometimes up to eight times their normal size, and may compress the optic nerve (Fig. 17.16). Subsequent degeneration of muscle fibres eventually leads to fibrosis, which exerts a tethering effect on the involved muscle, resulting in restrictive myopathy and diplopia.
2. **Inflammatory cellular infiltration** with lymphocytes, plasma cells, macrophages and mast cells of the interstitial tissues, orbital fat and lacrimal glands with accumulation of glycosaminoglycans and retention of fluid. This causes increase in the volume of orbital contents and secondary elevation of intraorbital pressure, which may itself cause further fluid retention within the orbit.

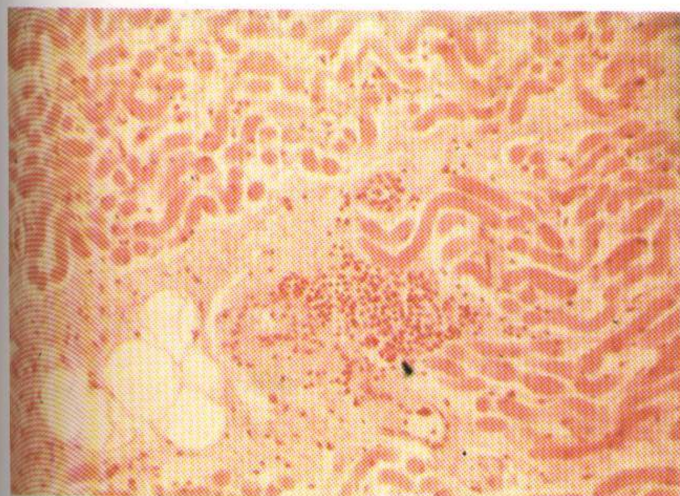


Fig. 17.15
Round cell infiltration of an extraocular muscle in thyroid eye disease

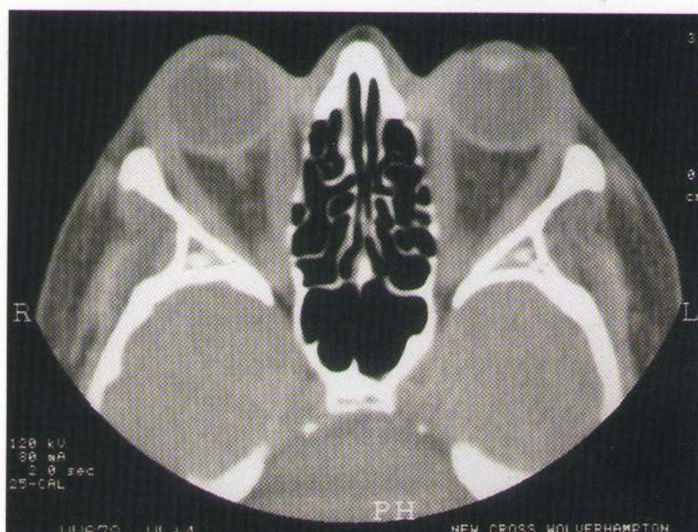


Fig. 17.16
Axial CT scan showing enlarged extraocular muscles in thyroid eye disease

Clinical manifestations

TED may precede, coincide with or follow hyperthyroidism and bears no relationship to the severity of thyroid dysfunction. It may vary from being merely a nuisance, to blindness secondary to exposure keratopathy or optic neuropathy. The five main clinical manifestations of TED are: (a) *soft tissue involvement*, (b) *lid retraction*, (c) *proptosis*, (d) *optic neuropathy* and (e) *restrictive myopathy*. There are two stages in the development of the disease:

1. **Congestive** (inflammatory) stage in which the eyes are red and painful. This tends to remit within 3 years and only 10% of patients develop serious long-term ocular problems.
2. **Fibrotic** (quiescent) stage in which the eyes are white, although a painless motility defect may be present.

Soft tissue involvement

Clinical features

1. **Symptoms** include grittiness, photophobia, lacrimation and retrobulbar discomfort.
2. **Signs**
   a. ***Periorbital and lid swelling*** is caused by oedema and infiltration behind the orbital septum which may be associated with prolapse of retroseptal fat into the eyelids (Fig. 17.17).

b. ***Conjunctival and episcleral hyperaemia*** is a sensitive sign of inflammatory activity. Intense focal hyperaemia may outline the insertions of the horizontal recti (Fig. 17.18).

c. ***Chemosis*** refers to oedema of the conjunctiva and caruncle. If minimal it is manifest as a small fold of redundant conjunctiva overhanging the lower lid margin. In severe cases the conjunctiva prolapses between the lids (Fig. 17.19).

d. ***Superior limbic keratoconjunctivitis*** (Fig. 17.20).

e. ***Keratoconjunctivitis sicca*** secondary to infiltration of the lacrimal glands.



Fig. 17.17
Severe periorbital swelling in thyroid eye disease



Fig. 17.18
Conjunctival and episcleral injection over a horizontal rectus muscle in thyroid eye disease



Fig. 17.19
Severe chemosis in thyroid eye disease

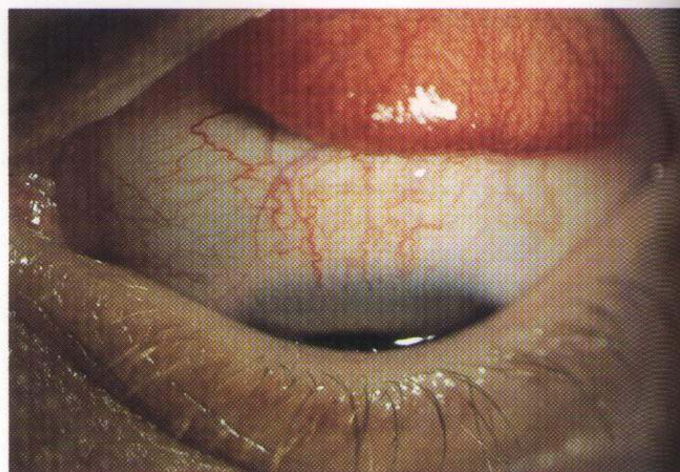


Fig. 17.20
Superior limbic keratoconjunctivitis in thyroid eye disease

Management

1. **Topical lubricants** for superior limbic keratoconjunctivitis, corneal exposure and dryness.
2. **Head elevation** with three pillows during sleep to reduce periorbital oedema.
3. **Taping of the eyelids** during sleep may alleviate mild exposure keratopathy.

Lid retraction

Pathogenesis

Retraction of upper and lower lids occurs in about 50% of patients with Graves disease as a result of the following postulated mechanisms:

1. **Fibrotic contracture** of the levator associated with adhesions with the overlying orbital tissues causes lid retraction, worse on downgaze. Fibrosis of the inferior rectus muscle may similarly induce retraction of the lower eyelid via its capsulopalpebral head.
2. **Secondary overaction** of the levator–superior rectus complex in response to hypophoria produced by fibrosis and tethering of the inferior rectus muscle, evidenced by increased lid retraction from downgaze to upgaze. Retraction of the lower eyelid resulting from overaction of the inferior rectus may also occur secondary to fibrosis of the superior rectus muscle.
3. **Humorally induced overaction** of Müller muscle as a result of sympathetic overstimulation secondary to high levels of thyroid hormones. Supporting this hypothesis is the observation that lid retraction may sometimes be lessened by a topical sympatholytic drug (guanethidine); against it is the absence of associated pupillary dilatation and the fact that lid retraction may occur without hyperthyroidism.

Signs

The upper lid margin normally rests 2 mm below the limbus (Fig. 17.21, right eye). Lid retraction is suspected when the



Fig. 17.21
Right eye shows normal lid positions; left eye shows lid retraction and mild proptosis in thyroid eye disease (Courtesy of G. Rose)



Fig. 17.22
Bilateral lid retraction but no proptosis in thyroid eye disease (Courtesy of G. Rose)

margin is either level with or above the superior limbus, allowing sclera to be visible ('scleral show') (Fig. 17.21, left eye). Likewise, the lower eyelid normally rests at the inferior limbus; retraction is suspected when sclera shows below the limbus. Lid retraction may occur in isolation (Fig. 17.22) or in association with proptosis, which exaggerates its severity.

1. **Dalrymple** sign is lid retraction in primary gaze.
2. **von Graefe** sign signifies retarded descent of the upper lid on downgaze (Fig. 17.23).



Fig. 17.24
Kocher sign in thyroid eye disease

3. **Kocher** sign is a staring and frightened appearance of the eyes which is particularly marked on attentive fixation (Fig. 17.24).

Management

Mild lid retraction does not require treatment because it frequently improves spontaneously. Control of hyperthyroidism may also be beneficial. Surgery to decrease the vertical dimensions of the palpebral fissures may be considered in patients with significant but stable lid retraction, but only after addressing proptosis and strabismus. In general, therefore, the sequence of surgical procedures in TED is: (a) *orbit*, (b) *strabismus* and (c) *eyelid*. The rationale for this sequence is that orbital decompression may affect both ocular motility and eyelid position, and extraocular muscle surgery may also influence eyelid position. The main surgical procedures for lid retraction are:

1. **Inferior rectus recession** when inferior rectus fibrosis is thought to be significant.
2. **Müllerotomy** (disinsertion of Müller muscle) for mild lid retraction. More severe cases may also require recession/disinsertion of the levator aponeurosis and the suspensory ligament of the superior conjunctival fornix.
3. **Recession of lower lid retractors** with scleral graft when retraction of the lower lid is 2 mm or more.





Fig. 17.23
von Graefe sign (right eye) in thyroid eye disease

Proptosis

Signs

Proptosis is axial, unilateral or bilateral, symmetrical or asymmetrical, and frequently permanent. Severe proptosis (Fig. 17.25) may compromise lid closure, with resultant exposure keratopathy and corneal ulceration.

Management

This is controversial. Some favour early surgical decompression whereas others consider surgery only when non-invasive methods have failed or are inappropriate.

1. **Systemic steroids** may be used in rapidly progressive and painful proptosis during the congestive phase, unless contraindicated (e.g. tuberculosis or peptic ulceration).
   a. *Oral prednisolone* 60–80 mg/day is given initially. Reduction in discomfort, chemosis and periorbital oedema usually occurs within 48 hours, at which point the dose should be tapered. Maximal response is usually achieved within 2–8 weeks. Ideally steroid therapy should be discontinued after about 3 months, although long-term low-dose maintenance may be necessary.
   b. *Intravenous methylprednisolone* (0.5 g in 200 ml isotonic saline given over 30 minutes), which may be repeated after 48 hours, may also be effective but is usually reserved for compressive optic neuropathy. This is because of potential cardiovascular risks which mandate supervision by a physician.
2. **Radiotherapy** is an alternative when steroids are contraindicated or ineffective. A positive response is usually evident within 6 weeks, with maximal improvement by 4 months.
3. **Combined therapy** with irradiation, azathioprine and low-dose prednisolone may be more effective than steroids or radiotherapy alone.
4. **Surgical decompression** may be considered either as primary treatment or when non-invasive methods are ineffective, such as for cosmetically unacceptable proptosis in the quiescent phase. Decompression, which is often performed endoscopically, may involve the following:
   a. *Two-wall* (antral–ethmoidal) involves removal of a part of the floor and the posterior portion of the medial wall (Fig. 17.26). This affords 3–6 mm of retroplacement of the globe.
   b. *Three-wall* involves an antral–ethmoidal decompression and removal of the lateral wall. The amount of retroplacement achieved is 6–10 mm.
   c. *Four-wall* involves a three-wall decompression, removal of the lateral half of the orbital roof and a large portion of the sphenoid at the apex of the orbit. This affords 10–16 mm of retroplacement and is reserved for very severe proptosis.

Optic neuropathy

Optic neuropathy is a serious complication affecting about 5% of patients. It is caused by compression of the optic nerve or its blood supply at the orbital apex by the congested and enlarged recti. Such compression, which may occur in the absence of significant proptosis, may lead to severe, permanent, but preventable visual impairment.

Clinical features

1. **Presentation** is with impairment of central vision. In order to detect early involvement, patients should be advised to monitor their own visual function by alternatively occluding each eye and reading small print and assessing the intensity of colours, for example, on a television screen.
2. **Signs**
   - Visual acuity is usually reduced, but not invariably, and is associated with a relative afferent pupillary defect, colour desaturation and diminished light brightness appreciation.
   - Visual field defects may be central or paracentral and may be combined with nerve fibre bundle defects. These



Fig. 17.25
Severe bilateral proptosis and lid retraction in thyroid eye disease (Courtesy of G. Rose)

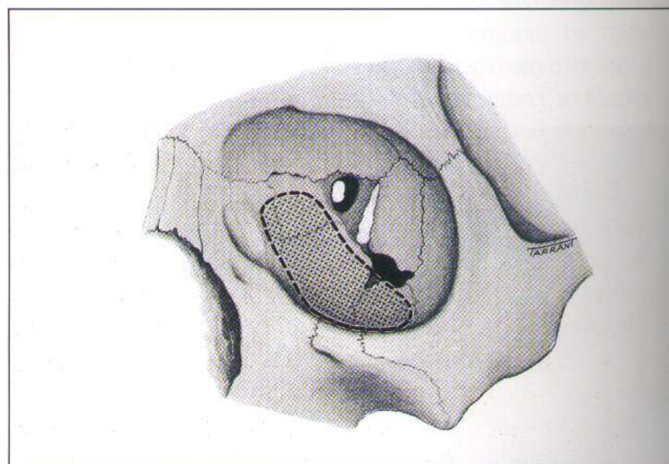


Fig. 17.26
Two-wall orbital decompression

findings, combined with elevated intraocular pressure, may be confused with primary open-angle glaucoma (*see* below).

- The optic disc is usually normal, occasionally swollen and rarely atrophic.

> ***NB:*** It is important not to attribute disproportionate visual loss to minor corneal complications and miss optic neuropathy.

Treatment

Initial treatment is usually with intravenous methylprednisolone. Orbital decompression may be considered if this is ineffective or inappropriate.

Restrictive myopathy

Signs

Between 30% and 50% of patients with TED develop ophthalmoplegia which may be permanent. Ocular motility is restricted initially by inflammatory oedema and later by fibrosis. Intraocular pressure may increase in upgaze due to ocular compression by a fibrotic inferior rectus. Occasionally, there may be a sustained increase in the intraocular pressure through compression of the globe by a combination of fibrotic extraocular muscles and increased intraorbital pressure. In order of frequency the four ocular motility defects are:

1. **Elevation** defect caused by fibrotic contracture of the inferior rectus (Fig. 17.27), which may mimic a superior rectus palsy.
2. **Abduction** defect due to fibrosis of the medial rectus (Fig. 17.28), which may simulate sixth nerve palsy.
3. **Depression** defect secondary to fibrosis of the superior rectus.
4. **Adduction** defect caused by fibrosis of the lateral rectus.

Management

1. **Surgery**
   a. ***The indication*** is diplopia in the primary or reading positions of gaze, provided the disease is quiescent and the angle of deviation has been stable for at least 6 months. Until these criteria are met diplopia may be alleviated, if possible, with prisms.
   b. ***The goal*** is to achieve binocular single vision in the primary and reading positions. Restrictive myopathy, which causes incomitant strabismus, often precludes binocularity in all positions of gaze. However, with time the field of binocular single vision may enlarge as a result of increasing vergences.
   c. ***The technique*** most commonly involves recession of the inferior and/or medial recti, for best results on adjustable sutures. The suture is adjusted on the first postoperative day to obtain optimal alignment, and the patient is encouraged to practise achieving single vision with a distant target such as a television.



Fig. 17.27
Restricted left elevation due to a tight left inferior rectus in thyroid eye disease



Fig. 17.28
Restricted left abduction due to a tight left medial rectus in thyroid eye disease

2. **Botulinum toxin injection** into the involved muscle may be useful in selected cases.

Infections

Preseptal cellulitis

Preseptal cellulitis is an infection of the subcutaneous tissues anterior to the orbital septum. Although not strictly an orbital disease, it is included hereunder because it must be differentiated from the much less common but potentially more serious orbital cellulitis. Occasionally rapid progression to orbital cellulitis may occur.

1. **Causes**
   a. ***Skin trauma*** such as laceration or insect bites. The offending organism is usually *Staph. aureus* or *Strep. pyogenes.*
   b. ***Spread of local infection***, such as from an acute hordeolum or dacryocystitis.
   c. ***From remote infection*** of the upper respiratory tract or middle ear by haematogenous spread.
2. **Signs**. Unilateral, tender, and red periorbital and lid oedema (Fig. 17.29).


Fig. 17.29
Preseptal cellulitis due to a skin laceration


Fig. 17.30
Sinus-related orbital cellulitis

> ***NB:*** Unlike orbital cellulitis proptosis is absent. Visual acuity, pupillary reactions and ocular motility are unimpaired.

3. **Treatment** is with oral co-amoxiclav 250 mg every 6 hours. Very severe infection may require intramuscular benzylpenicillin 2.4–4.8 mg in four divided doses and oral flucloxacillin 250–500 mg every 6 hours.

Bacterial orbital cellulitis

Bacterial orbital cellulitis is a life-threatening infection of the soft tissues behind the orbital septum. It can occur at any age but is more common in children. The most frequent causative organisms are *Strep. pneumoniae, Staph. aureus, Strep. pyogenes* and *H. influenzae.*

Causes

1. **Sinus-related**, most commonly ethmoidal, typically affects children and young adults.
2. **Extension of preseptal cellulitis** through the orbital septum.
3. **Local spread** from adjacent dacryocystitis, and mid-facial or dental infection. The last condition may cause orbital cellulitis via an intermediary maxillary sinusitis.
4. **Haematogenous spread**.
5. **Post-traumatic** develops within 72 hours of an injury that penetrates the orbital septum. The typical clinical features may be masked by associated laceration or haematoma.
6. **Post-surgical** may complicate retinal, lacrimal or orbital surgery.

Clinical features

1. **Presentation** is with a rapid onset of severe malaise, fever, pain and visual impairment.
2. **Signs**
   - Unilateral, tender, warm and red periorbital and lid oedema (Figs 17.30 and 17.31).


Fig. 17.31
Orbital cellulitis following retinal detachment surgery

   - Proptosis, which is often obscured by lid swelling, is most frequently lateral and downwards.
   - Painful ophthalmoplegia.
   - Optic nerve dysfunction.

Complications

1. **Ocular** complications include exposure keratopathy, raised intraocular pressure, occlusion of the central retinal artery or vein, endophthalmitis and optic neuropathy.
2. **Intracranial** complications, which are rare, include meningitis, brain abscess and cavernous sinus thrombosis. The last is a rare but extremely serious complication which should be suspected when there is evidence of bilateral involvement, rapidly progressive proptosis and congestion of the facial, conjunctival and retinal veins. Additional features include abrupt progression of all clinical signs associated with prostration, severe headache, nausea and vomiting.
3. **Subperiosteal abscess** is most frequently located along the medial orbital wall. It is a serious problem because of the potential for rapid progression and intracranial extension.



Fig. 17.32
Discharging orbital abscess



Fig. 17.33
Axial CT scan showing left preseptal cellulitis

4. **Orbital abscess** is relatively rare in sinus-related orbital cellulitis but may occur in post-traumatic or postoperative cases (Fig. 17.32).

Management

1. **Hospital admission** with frequent ophthalmic and otolaryngological assessment is mandatory. Intracranial abscess formation may necessitate neurosurgical drainage.
2. **Antibiotic therapy** involves intramuscular ceftazidime 1 g every 8 hours and oral metronidazole 500 mg every 8 hours to cover anaerobes. Intravenous vancomycin is a useful alternative in the context of penicillin allergy. Antibiotic therapy should be continued until the patient is apyrexial for 4 days.
3. **Optic nerve function** should be monitored every 4 hours by testing pupillary reactions, visual acuity, colour vision and light brightness appreciation.
4. **Investigations**, where appropriate, include the following:
   - White cell count.
   - Blood culture.
   - CT of the orbit, sinuses and brain. Orbital CT is useful in the differentiation between severe preseptal cellulitis and orbital cellulitis (Fig. 17.33).
   - Lumbar puncture if meningeal or cerebral signs develop.
5. **Surgical intervention** should be considered in the following circumstances:
   - Unresponsiveness to antibiotics.
   - Decreasing vision.
   - Orbital or subperiosteal abscess.
   - Atypical picture, which may merit diagnostic biopsy.

> ***NB:*** It is usually necessary to drain the infected sinuses as well as the orbit.

Rhino-orbital mucormycosis

Mucormycosis is a rare opportunistic infection caused by fungi of the family *Mucoraceae*, which typically affects patients with diabetic ketoacidosis or immunosuppression. This aggressive and fatal infection is acquired by the inhalation of spores, which give rise to an upper respiratory infection. The infection then spreads to the contiguous sinuses and subsequently to the orbit and brain. Invasion of blood vessels by the hyphae results in occlusive vasculitis with ischaemic infarction of orbital tissues.

1. **Presentation** is with gradual-onset facial and periorbital swelling, diplopia and visual loss.
2. **Signs**
   - Ischaemic infarction superimposed on septic necrosis is responsible for the black eschar which may develop on the palate, turbinates, nasal septum, skin and eyelids (Fig. 17.34).
   - Ophthalmoplegia.
   - Progression is slower than in bacterial orbital cellulitis.
3. **Complications** include retinal vascular occlusion, multiple cranial nerve palsies and cerebrovascular occlusion.



Fig. 17.34
Necrosis of the eyelid in rhino-orbital mucormycosis

4. **Treatment**
   - Intravenous amphotericin.
   - Daily packing and irrigation of the involved areas with amphotericin.
   - Wide excision of devitalized and necrotic tissues.
   - Adjunctive hyperbaric oxygen may be helpful.
   - Correction of the underlying metabolic defect, if possible.
   - Exenteration may be required in severe unresponsive cases.

Inflammatory disease

Idiopathic orbital inflammatory disease

Idiopathic orbital inflammatory disease (IOID), previously referred to as orbital pseudo-tumour, is an uncommon disorder characterized by non-neoplastic, non-infectious, space-occupying, orbital lesions. The inflammatory process may involve any or all of the orbital soft tissues. Histopathological analysis reveals pleomorphic cellular inflammatory infiltration followed by reactive fibrosis, but has thus far shown no correlation between clinicopathological features and the subsequent course of the disease. Unilateral disease is the rule in adults, although in children bilateral involvement may occur. Simultaneous orbital and sinus involvement is a rare distinct entity.

Clinical features

1. **Presentation** is in the third to sixth decades with acute redness, swelling and pain, which is usually unilateral.
2. **Signs**
   - Congestive proptosis and ophthalmoplegia.
   - Optic nerve dysfunction if the inflammation involves the posterior orbit.
3. **Course**. This follows one of the following patterns:
   - Spontaneous remission after a few weeks without sequelae.
   - Prolonged intermittent episodes of activity with no eventual remission.
   - Severe prolonged inflammation eventually leading to progressive fibrosis of orbital tissues, resulting in a 'frozen orbit' characterized by ophthalmoplegia (Fig. 17.35a–c), which may be associated with ptosis and visual impairment caused by optic nerve involvement.

Management

1. **Observation**, for relatively mild disease, in anticipation of spontaneous remission.
2. **Biopsy** may be required in persistent cases to confirm the diagnosis and to rule out neoplasia.
3. **Systemic steroids** are effective in 50–75% of patients with moderate to severe involvement. Oral prednisolone, initially 60–80 mg/day, is later tapered and discontinued, depending on clinical response, although it may need to be reintroduced in the event of recurrence.
4. **Radiotherapy** may be considered if there has been no improvement after 2 weeks of adequate steroid therapy. Even a low-dose treatment (i.e. 10 Gy) may produce long-term, and sometimes permanent, remission.
5. **Cytotoxic drugs** such as cyclophosphamide 200 mg/day may be necessary in the context of resistance to both steroids and radiotherapy.







Fig. 17.35
Ophthalmoplegia due to a 'frozen orbit' (Courtesy of G. Rose)

Differential diagnosis

1. **Bacterial orbital cellulitis** should be considered when the anterior orbital tissues are markedly inflamed. A trial of systemic antibiotics may be necessary before the correct diagnosis becomes apparent.
2. **Severe acute TED** shares many features with IOID, but is commonly bilateral, while IOID is usually unilateral.
3. **Systemic disorders** such as Wegener granulomatosis, polyarteritis nodosa and Waldenström macroglobulinaemia may manifest orbital involvement similar to IOID.
4. **Malignant orbital tumours**, particularly metastatic.
5. **Ruptured dermoid cyst** may evoke a secondary painful granulomatous inflammatory reaction.

Acute dacryoadenitis

Lacrimal gland involvement occurs in about 25% of patients with IOID. More commonly, however, dacryoadenitis occurs in isolation, resolves spontaneously and does not require treatment.

Clinical features

1. **Presentation** is with acute discomfort in the region of the lacrimal gland.
2. **Signs**
   - Swelling of the lateral aspect of the eyelid giving rise to a characteristic S-shaped ptosis and mild downward and inward dystopia (Fig. 17.36).
   - Tenderness over the lacrimal gland fossa.
   - Injection of the palpebral portion of the lacrimal gland and adjacent conjunctiva (Fig. 17.37).
   - Lacrimal secretion may be reduced.

Differential diagnosis

1. **Lacrimal gland infection** caused by mumps, mononucleosis and, less commonly, bacteria.
2. **Ruptured dermoid cyst** may cause localized inflammation in the region of the lacrimal gland.



Fig. 17.36
Acute right dacryoadenitis (Courtesy of G. Rose)



Fig. 17.37
Injection of the lacrimal gland and adjacent conjunctiva in acute dacryoadenitis

3. **Malignant lacrimal gland tumours** may cause pain but the onset is not usually acute.

Orbital myositis

This idiopathic, non-specific inflammation of one or more extraocular muscles is considered a subtype of IOID.

Clinical features

1. **Presentation** is usually in early adult life with acute pain exacerbated by eye movements and diplopia.
2. **Signs**
   - Lid oedema, ptosis and chemosis.
   - Worsening of pain on attempted gaze into the field of action of the involved muscle(s), usually associated with diplopia due to underaction.
   - Vascular injection over the involved muscle.
   - Mild proptosis.
3. **CT** shows fusiform enlargement of the affected muscles, with or without involvement of the tendons of insertion (Fig. 17.38).
4. **Differential diagnosis** includes orbital cellulitis, dysthyroid myopathy and Tolosa–Hunt syndrome.

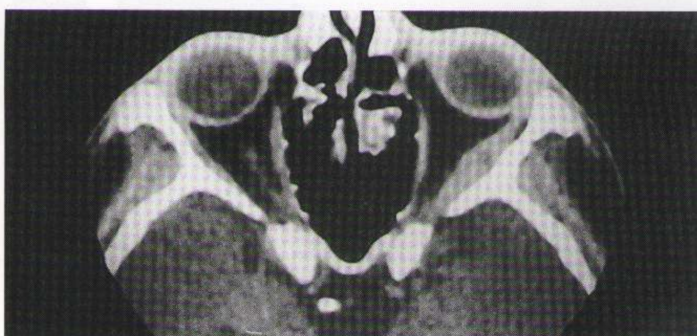


Fig. 17.38
Axial CT scan showing fusiform enlargement of the left lateral rectus muscle in orbital myositis

5. Course

a. Acute non-recurrent involvement which resolves spontaneously within 6 weeks.

b. Chronic disease characterized by either a single episode persisting for longer than 2 months (often for years) or recurrent attacks that may result in permanent restrictive myopathy.

Treatment

This is aimed at relieving discomfort and dysfunction, shortening the course and preventing recurrences.

1. **NSAIDs** may be adequate in mild disease.
2. **Systemic steroids** are generally required and usually produce dramatic improvement, although recurrences occur in 50% of cases.
3. **Radiotherapy** is also effective, particularly in limiting recurrence.

Tolosa–Hunt syndrome

This rare condition is caused by non-specific granulomatous inflammation of the cavernous sinus, superior orbital fissure and/or orbital apex. The clinical course is characterized by remissions and recurrences.

1. **Presentation** is with diplopia associated with ipsilateral periorbital or hemicranial pain.
2. **Signs**
   - Proptosis, if present, is usually mild.
   - Ocular motor nerve palsies often with involvement of the pupil.
   - Sensory loss along the distribution of the first and second divisions of the trigeminal nerve.
3. **Treatment** is with systemic steroids.

Wegener granulomatosis

Wegener granulomatosis (*see* Chapter 20) involves the orbit, often bilaterally, usually by contiguous spread from the paranasal sinuses or nasopharynx. Primary orbital involvement is less common. The possibility of Wegener granulomatosis should be considered in any patient with bilateral orbital inflammation, particularly if associated with sinus pathology. The antineutrophilic cytoplasmic antibody (cANCA) is a very useful serological test.

1. **Signs**
   - Proptosis, orbital congestion and ophthalmoplegia (often bilateral).
   - Dacryoadenitis and nasolacrimal duct obstruction.
   - Coexistent manifestations include scleritis and peripheral ulcerative keratitis.
2. **Treatment**
   - Systemic cyclophosphamide and steroids are highly effective. In resistant cases cyclosporin, azathioprine, antithymocyte globulin or plasmapheresis may be useful.
   - Surgical orbital decompression may be required for severe orbital involvement.

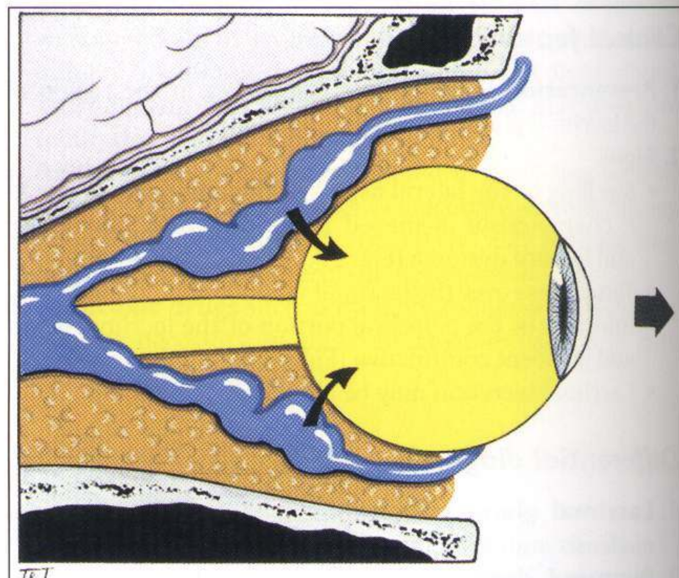
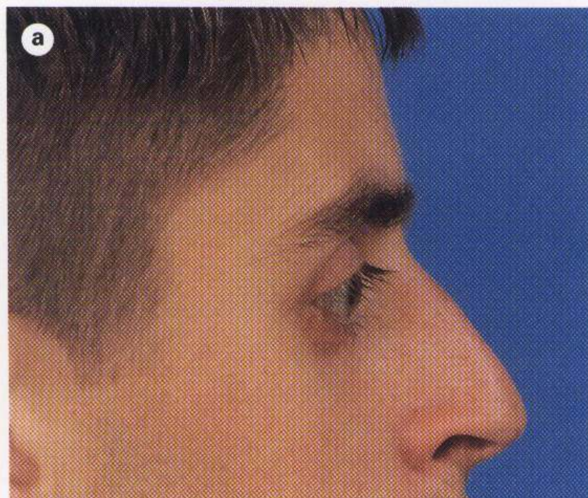


Fig. 17.39
Mechanism of intermittent proptosis caused by orbital varices



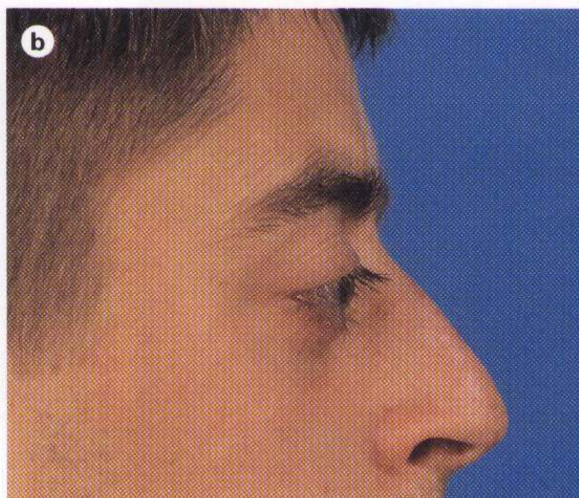


Fig. 17.40
Orbital varices. (**a**) Before Valsalva manoeuvre; (**b**) with Valsalva manoeuvre

Vascular malformations

Primary varices

Primary varices consist of weakened segments of the orbital venous system, of variable length and complexity. Intrinsic to the circulation, they enlarge with increased venous pressure, their distensibility varying with the residual thickness and strength of their walls (Fig. 17.39). Most cases are unilateral and the most frequent site is upper nasal. CT and plain radiographs show phleboliths in about 20% of cases.

1. **Presentation** ranges from early childhood to late middle age.
2. **Signs**
   a. ***Intermittent proptosis*** without external signs. The proptosis is non-pulsatile and is not associated with a bruit. As the orbital veins are devoid of valves, rapidly reversible proptosis may be precipitated or accentuated by increasing venous pressure through coughing, straining, Valsalva manoeuvre (Fig. 17.40), assuming the dependent position or external compression of the jugular veins. Patients with long-standing lesions may develop atrophy of surrounding fat and enophthalmos associated with a deepened superior sulcus in the resting position, reversible with increase in venous pressure.
   b. ***Visible lesions*** in the eyelid (Fig. 17.41) and under the conjunctiva (Fig. 17.42), which may also be accentuated by performing the Valsalva manoeuvre.
   c. ***A combination*** of visible lesions and proptosis (the most common).
3. **Complications** include acute haemorrhage and thrombosis.
4. **Treatment** by surgical excision is technically difficult and often incomplete because the lesions are friable and bleed easily. Indications include recurrent thrombosis, pain, severe proptosis and optic nerve compression.

Lymphangioma

Lymphangiomas are not neoplasms but abortive, non-functional, benign vascular malformations that arborize through the orbit and may also involve the oropharynx. Although haemodynamically isolated from the circulation, bleeding into the lumen may occur with resultant blood-filled 'chocolate' cysts. Lymphangiomas may be confused with orbital venous anomalies and haemangiomas.

1. **Presentation** is usually in early childhood.
2. **Signs**
   a. ***Anterior lesions*** typically manifest several soft bluish masses in the upper nasal quadrant with an associated cystic conjunctival component.
   b. ***Posterior lesions*** may cause slowly progressive proptosis, or initially may lie dormant and later present with sudden painful proptosis secondary to spontaneous haemorrhage. The blood subsequently becomes encysted with the formation of 'chocolate cysts' which may regress spontaneously with time.
3. **Treatment** by surgical excision is difficult because lymphangiomas are friable, not encapsulated, bleed easily and may infiltrate normal orbital tissues. Persistent sight-threatening 'chocolate cysts' should be drained or removed subtotally by controlled vaporization using a carbon dioxide laser.



Fig. 17.42
Orbital varices extending under the conjunctiva





Fig. 17.41
Orbital varices involving the left eyelid. **(a)** Before Valsalva manoeuvre; **(b)** with Valsalva manoeuvre (Courtesy of G. Rose)

Carotid–cavernous fistula

An arteriovenous fistula is an abnormal communication between an artery and a vein. The blood within the affected vein becomes 'arterialized', the venous pressure rises, and venous drainage may be altered in both rate and direction. The arterial pressure and perfusion are also reduced. A carotid–cavernous fistula is one such communication between the carotid artery and the cavernous sinus. When arterial blood flows anteriorly into the ophthalmic veins, ocular manifestations occur because of venous and arterial stasis around the eye and orbit, increased episcleral venous pressure and decrease in arterial blood flow to the cranial nerves within the cavernous sinus. Carotid–cavernous fistulae can be classified on the basis of: (a) *aetiology* (spontaneous and traumatic), (b) *haemodynamics* (high and low flow) and (c) *anatomy* (direct and indirect).

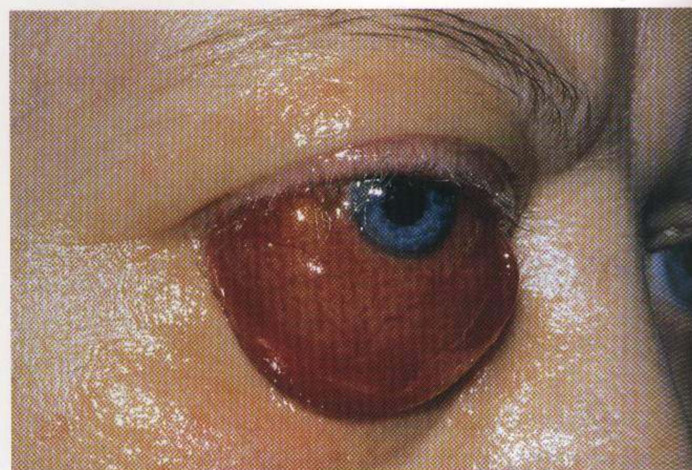


Fig. 17.43
Chemosis in a high-flow carotid–cavernous fistula

Direct carotid–cavernous fistula

Representing 70–90% of all cases, direct fistulae are high-flow shunts in which carotid artery blood passes directly into the cavernous sinus through a defect in the wall of the intracavernous portion of the internal carotid artery as a result of the following:

1. **Trauma** is responsible for 75% of cases. A basal skull fracture may cause a tear in the intracavernous internal carotid artery with sudden and dramatic onset of symptoms and signs.
2. **Spontaneous rupture** of an intracavernous carotid aneurysm or an atherosclerotic artery accounts for the remainder. Post-menopausal hypertensive women are at particular risk. Spontaneous fistulae usually have lower flow rates and less severe symptoms than traumatic fistulae.

Clinical features

1. **Presentation** may be days or weeks after head injury with the classic triad of pulsatile proptosis, conjunctival chemosis and a flushing noise in the head.
2. **Signs** are usually ipsilateral to the fistula but may be bilateral or even contralateral because of the vascular connections across the midline between the two cavernous sinuses.
   a. Anterior
   - Ptosis and chemosis (Fig. 17.43).
   - Pulsatile proptosis associated with a bruit and a thrill, both of which can be abolished by ipsilateral carotid compression in the neck. A cephalic bruit may also be present.
   - Increased intraocular pressure from elevated episcleral venous pressure and orbital congestion.
   - Anterior segment ischaemia characterized by corneal epithelial oedema, aqueous cells and flare, iris atrophy, cataract and rubeosis iridis.

   b. Ophthalmoplegia occurs in 60–70% of cases due to ocular motor nerve damage by the initial trauma, the intracavernous carotid aneurysm or by the fistula itself. The sixth nerve is most frequently affected because of its free location within the cavernous sinus. The third and fourth nerves, situated in the lateral wall of the sinus, are less frequently involved. Engorgement and swelling of extraocular muscles may also contribute to defective ocular motility.

   c. Fundus examination shows optic disc swelling, venous dilatation and intraretinal haemorrhages from venous stasis and impaired retinal blood flow. Preretinal or vitreous haemorrhages are rare.
3. **Special investigations**. CT and MRI will show prominence of the superior ophthalmic vein and diffuse enlargement of extraocular muscles. Definitive diagnosis involves arterial angiography with selective injection of both internal and external carotid arteries, and the vertebral circulation.
4. **Visual prognosis** is poor, about 90% of patients developing severe visual loss.
   a. Immediate visual loss may be due to coincidental ocular or optic nerve damage at the time of head trauma.
   b. Delayed visual loss may be due to a variety of complications such as exposure keratopathy, secondary glaucoma, central retinal vein occlusion, anterior segment ischaemia or ischaemic optic neuropathy.

Treatment

Most carotid–cavernous fistulae are not life-threatening; the major organ at risk is the eye. Surgery is indicated if spontaneous closure secondary to thrombosis of the cavernous sinus does not occur. A post-traumatic fistula is much less likely to close on its own than a spontaneous fistula because of higher blood flow.

1. **Indications** for treatment are secondary glaucoma, diplopia, intolerable bruit or headache, severe proptosis

causing exposure keratopathy and anterior segment ischaemia.

2. **Interventional radiology** involves detachable balloon occlusion of the fistula. The balloon is introduced into the cavernous sinus either by an arterial route, through the tear in the internal carotid artery, or by a venous route, through the inferior petrosal sinus or the superior ophthalmic vein.

Indirect carotid–cavernous fistula

In an indirect carotid–cavernous fistula (dural shunt), the intracavernous portion of the internal carotid artery remains intact. Arterial blood flows through the meningeal branches of the external or internal carotid arteries indirectly into the cavernous sinus. Due to slow blood flow, the clinical features are more subtle than in a direct fistula. The condition may therefore be misdiagnosed or missed altogether.

1. **Types**
   - Between meningeal branches of the internal carotid artery and the cavernous sinus.
   - Between meningeal branches of the external carotid artery and the cavernous sinus.
   - Between meningeal branches of both the external and internal carotid arteries and the cavernous sinus.
2. **Causes**
   a. ***Congenital malformations***, in which the onset of symptoms is precipitated by intracranial vascular thrombosis.
   b. ***Spontaneous rupture***, which may be precipitated by minor trauma or straining, especially in hypertensive patients.
3. **Presentation** is with gradual onset of redness of one or both eyes caused by conjunctival vascular engorgement.
4. **Signs** are variable.
   - Dilated conjunctival and episcleral vessels (Fig. 17.44).
   - Exaggerated ocular pulsation best detected on applanation tonometry.
   - Raised intraocular pressure.
   - Mild proptosis occasionally associated with a soft bruit.
   - Ophthalmoplegia most frequently caused by a sixth nerve palsy.
   - Fundus may be normal or manifest moderate venous dilatation.
5. **Differential diagnosis** includes chronic conjunctivitis, thyroid eye disease, glaucoma caused by some other pathology and orbital arteriovenous malformations which may mimic dural shunts.
6. **Treatment** involving 'interventional radiology' to occlude the feeding arteries is often required although some patients recover spontaneously.

Cystic lesions

Dacryops

A dacryops is a ductal cyst of the lacrimal gland. It is the most common orbital cystic lesion and is frequently bilateral.

1. **Signs**. A round, cystic lesion originating from the palpebral portion of the lacrimal gland which protrudes into the superior fornix (Fig. 17.45).
2. **Treatment** is by simple aspiration.

Dermoid cyst

A dermoid cyst is a benign cystic teratoma (choristoma) derived from displacement of ectoderm to a subcutaneous location along embryonic lines of closure. Dermoids are lined by keratinized stratified squamous epithelium (like skin), have a fibrous wall and contain dermal appendages such as sweat glands, sebaceous glands and hair follicles. Epidermoid cysts do not contain such adnexal structures. Dermoids may be (a) *superficial* or (b) *deep*, located anterior or posterior to the orbital septum respectively.

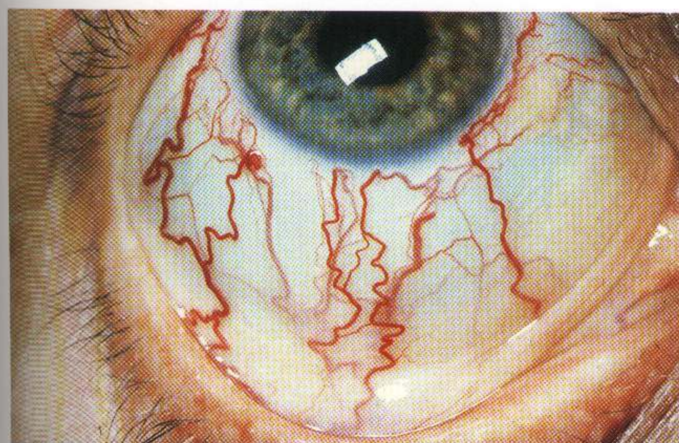


Fig.17.44
Dilated conjunctival and episcleral vessels in a low-flow carotid–cavernous fistula (Courtesy of K. Sehmi)

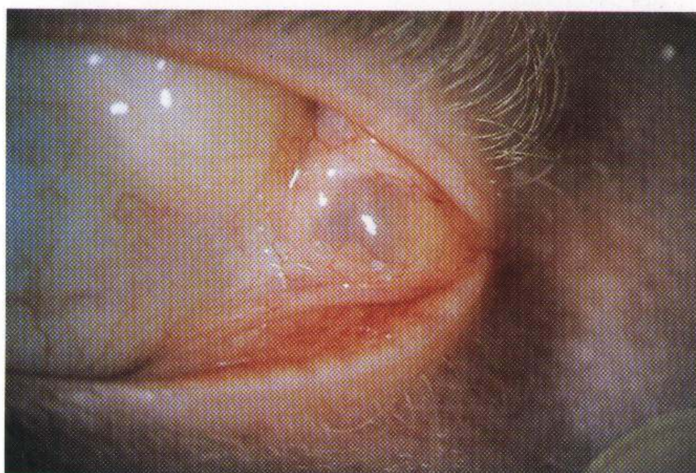


Fig. 17.45
Dacryops of the lacrimal gland

Superficial dermoid cyst

1. **Presentation** is in infancy with a painless nodule most commonly located in the superotemporal and occasionally the superonasal part of the orbit.
2. **Signs**. A firm, round, smooth, non-tender mass 1–2 cm in diameter which is freely mobile under the skin (Fig. 17.46). The posterior margins are easily palpable, denoting lack of deeper origin or extension.
3. **Treatment** is by excision *in toto*, taking care not to rupture the lesion, since leaking of keratin into the surrounding tissue results in severe granulomatous inflammation.



Fig. 17.46
Superficial dermoid

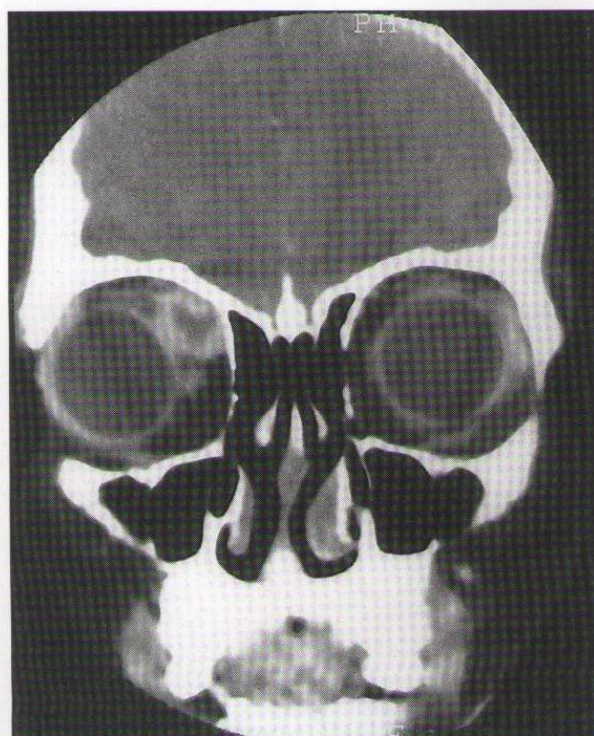


Fig. 17.47
Coronal CT scan showing a deep dermoid in the right medial orbit

Deep dermoid cyst

1. **Presentation** is in adolescence or adult life.
2. **Signs**. Proptosis, dystopia or a mass lesion with indistinct posterior margins. Some deep dermoids, associated with bony defects, may extend into the infratemporal fossa or intracranially.
3. **CT** shows a heterogeneous, well-circumscribed lesion (Fig. 17.47).
4. **Treatment** by excision *in toto* is advisable because deep dermoids enlarge and may leak their contents into adjacent tissues. This induces a painful granulomatous inflammation, often followed by fibrosis. If incompletely excised, they may recur and cause persistent low-grade inflammation.

Mucocele

A mucocele develops when the drainage of normal paranasal sinus secretions is obstructed due to infection, allergy, trauma, tumour or congenital narrowing. A slowly expanding cystic accumulation of mucoid secretions and epithelial debris develops and gradually erodes the bony walls of the sinuses, causing symptoms by encroaching upon surrounding tissues. Orbital invasion occurs usually from frontal or ethmoidal mucoceles, and rarely from those arising in the maxillary sinus.

1. **Presentation** is in adult life with proptosis, dystopia, diplopia or epiphora. Pain is uncommon unless secondary infection develops (mucopyocele).
2. **Signs**. Frontal tenderness, proptosis or dystopia (Fig. 17.48), and periorbital or upper lid swelling (Fig. 17.49).
3. **CT** shows a soft tissue mass with thinning of the bony walls of the sinus.
4. **Treatment** involves complete removal of the mucocele, with re-establishment of normal sinus drainage or obliteration of the sinus cavity.

Encephalocele

An encephalocele is formed by herniation of intracranial contents through a congenital defect of the base of the

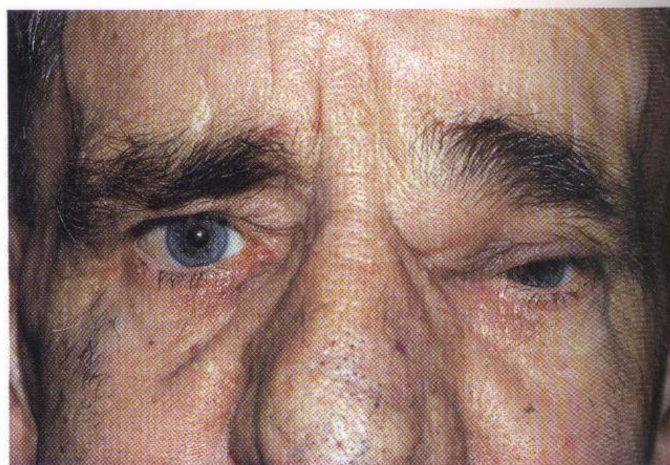


Fig. 17.48
Left dystopia due to a frontal mucocele

skull. A meningocele contains only dura, while a meningo-encephalocele also contains brain tissue. Orbital encephalocele may be (a) *anterior* (fronto-ethmoidal) or (b) *posterior* (associated with dysplasia of the sphenoid bone).

1. **Presentation** is usually during infancy.
2. **Signs**
   - Anterior encephaloceles involve the superomedial part of the orbit and displace the globe forwards and laterally (Fig. 17.50). Posterior encephaloceles displace the globe forwards and downwards.
   - The cyst increases in size on straining or crying and may be reduced by manual pressure.
   - Pulsating proptosis may occur due to communication with the subarachnoid space but, because the communication is not vascular, there is neither a thrill nor a bruit (Fig. 17.51).
3. **CT** shows the bony defect responsible for the herniation.
4. **Differential diagnosis**
   a. Of anterior encephaloceles includes other causes of medial canthal swellings such as dermoid cysts and amniontoceles of the lacrimal sac (*see* Fig. 2.24).
   b. Of posterior encephaloceles includes other orbital lesions that present during early life such as capillary haemangioma, juvenile xanthogranuloma, teratoma and microphthalmos with cyst.
5. **Associations**
   a. Other bony abnormalities such as hypertelorism, broad nasal bridge and cleft palate.
   b. Ocular associations include microphthalmos, colobomas and the morning glory syndrome.
   c. Neurofibromatosis-1 is frequently associated with posterior encephalocele.



Fig. 17.49
Swelling in the upper eyelid due to a frontal mucocele
(Courtesy of C. Barry)



Fig. 17.50
Anterior encephalocele

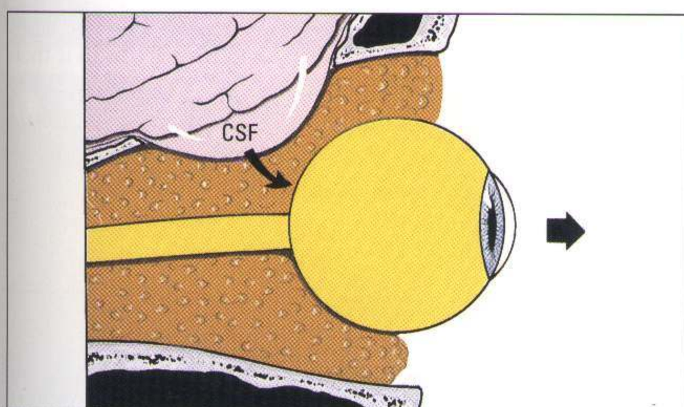


Fig. 17.51
Mechanism of pulsatile proptosis in an encephalocele

Tumours

Capillary haemangioma

The capillary haemangioma is the most common tumour of the orbit and periorbital areas in childhood. This hamartoma may present as a small isolated lesion of minimal clinical significance or as a large disfiguring mass that can cause visual impairment and systemic complications.



Fig. 17.52
Subcutaneous capillary haemangioma and a cutaneous strawberry naevus

Clinical features

The diagnosis can usually be made on inspection alone. The lesions may be superficial, subcutaneous, deep or in combination with various appearances and ocular effects.

1. **Presentation** is usually in the perinatal period, but never at birth.
2. **Signs**
   - Superficial 'strawberry' naevus on the eyelids is common.
   - Subcutaneous haemangioma in the eyelids or superficial orbit that appears dark blue or purple through the overlying skin (Fig. 17.52).
   - The superior anterior orbit is most commonly involved and the tumour may cause dystopia (Fig. 17.53).
   - Deep orbital tumour which gives rise to unilateral proptosis without skin discoloration.
   - Haemangiomatous involvement of the palpebral or forniceal conjunctiva is common and may be an important diagnostic clue.
   - A large tumour may enlarge and change in colour to a deep blue during crying or straining, but both pulsation and a bruit are absent.
   - Coexisting capillary haemangiomas on other parts of the body are present in about 25% of cases.
3. **CT** may be required for deep lesions when the diagnosis is not apparent on inspection. The lesion appears as a homogeneous soft tissue mass in the anterior orbit or as an extraconal mass with 'finger-like' posterior expansions. The orbital cavity may show enlargement but there is no bony erosion.
4. **Course**. This is characterized by growth until the age of 1 year (Fig. 17.54) followed by gradual spontaneous involution starting at about 2 years. Complete resolution occurs in 40% by the age of 4 years and 70% by 7 years.

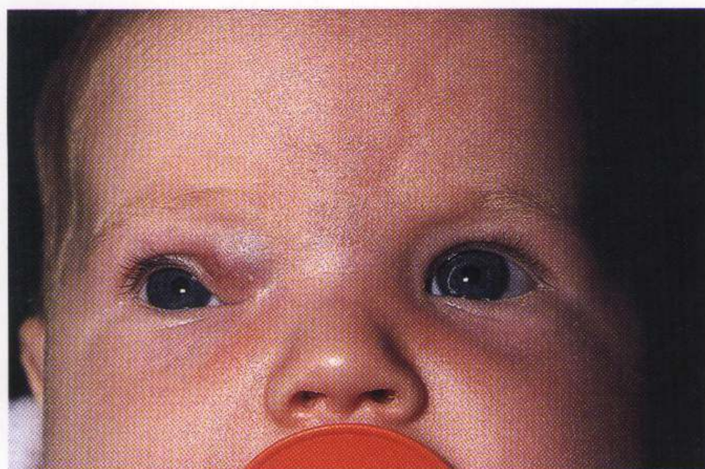


Fig. 17.53
Early anterior orbital capillary haemangioma

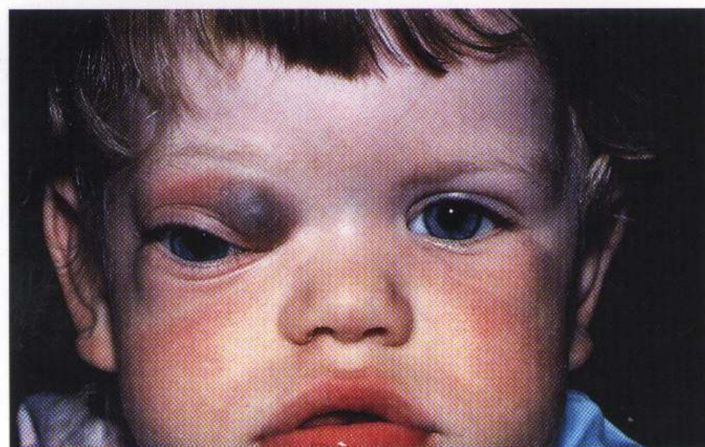


Fig. 17.54
The same patient several months later showing enlargement of the haemangioma

Systemic associations

Children with large haemangiomas may have the following conditions:

1. **High-output heart failure**.
2. **Kasabach–Merritt syndrome**, characterized by thrombocytopenia, anaemia and low levels of coagulant factors.
3. **Maffuci syndrome**, characterized by skin haemangiomas, enchondromata of hands, feet and long bones as well as bowing of long bones.

Treatment

1. **Indications**
   - Amblyopia, most commonly secondary to induced astigmatism and anisometropia.
   - Optic nerve compression.
   - Exposure keratopathy.
   - A severe cosmetic blemish, necrosis or infection.
2. **Methods**
   a. ***Steroid injection*** (triamcinolone acetonide 40 mg combined with betamethasone 6 mg) into the lesion, if subcutaneous, is very effective during the early active stage. Potential complications include retrograde forcing of the solution into the central retinal artery, skin depigmentation and necrosis, bleeding and fat atrophy.
   b. ***Systemic steroids*** administered daily over several weeks may also be effective and are particularly useful if there is a large orbital component.
   c. ***Local resection*** with cutting cautery may reduce the bulk of an anterior circumscribed tumour, but is usually reserved for the late inactive stage.
   d. ***Low-dose radiotherapy***.

Cavernous haemangioma

The cavernous haemangioma is the most common benign orbital tumour in adults, with a female preponderance of 70%. Although it may develop anywhere in the orbit, it most frequently occurs within the muscle cone just behind the globe.



Fig. 17.55
Right axial proptosis due to a cavernous haemangioma

1. **Presentation** is in the fourth to fifth decades with slowly progressive unilateral proptosis. Growth may be accelerated in pregnancy.
2. **Signs**
   - Axial proptosis (Fig. 17.55) which may be associated with optic disc oedema (Fig. 17.56a) and choroidal folds (Fig. 17.56b and c).
   - A lesion at the orbital apex may compress the optic nerve without causing significant proptosis.
   - Gaze-evoked transient blurring of vision may occur.
3. **CT** shows a well-circumscribed oval lesion with slow contrast enhancement.
4. **Treatment** by surgical excision is required in most cases because the lesion gradually enlarges. The cavernous haemangioma, unlike its capillary counterpart, is usually well encapsulated (Fig. 17.56d) and relatively easy to remove.

Pleomorphic lacrimal gland adenoma

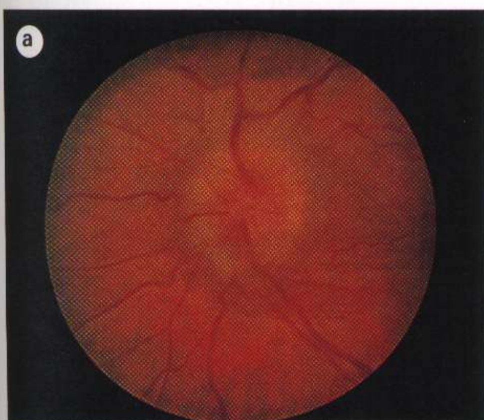
The pleomorphic adenoma (benign mixed-cell tumour) is the most common epithelial tumour of the lacrimal gland and is derived from the ducts, stroma and myoepithelial elements.

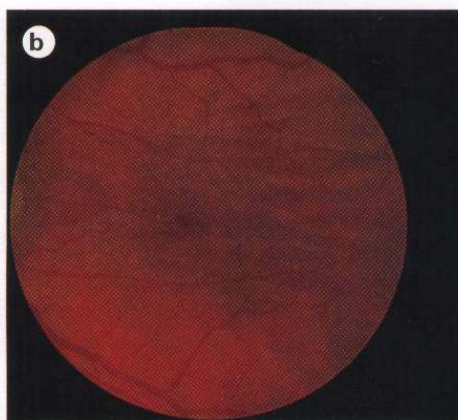
Clinical features

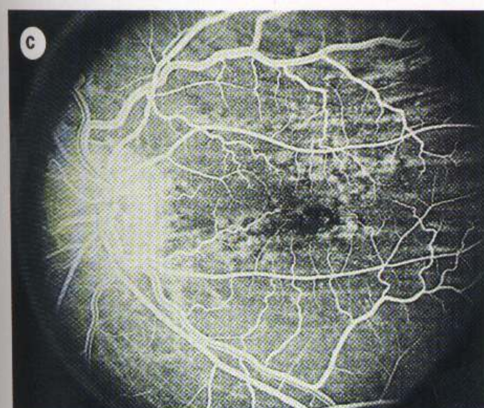
1. **Presentation** is in the fifth decade with a painless, slowly progressive swelling in the superolateral part of the orbit, usually of more than a year's duration.
2. **Signs**
   - A tumour arising from the *orbital lobe* is characterized by a smooth, firm, non-tender mass in the lacrimal gland fossa with inferonasal dystopia (Fig. 17.57).
   - Posterior extension may cause proptosis (Fig. 17.58), ophthalmoplegia and choroidal folds.



Fig. 17.57
Inferonasal dystopia due to pleomorphic adenoma of the orbital lobe of the lacrimal gland (Courtesy of G. Rose)







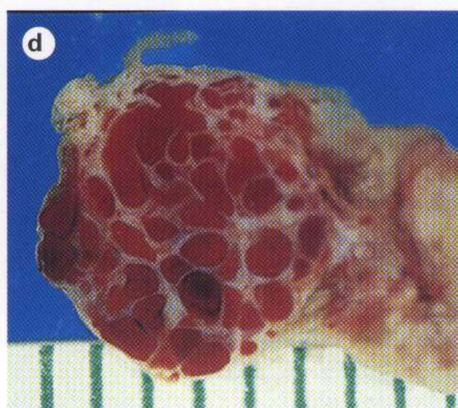


Fig. 17.56
Cavernous haemangioma of the orbit (*see text*) (Courtesy of Wilmer Institute)



Fig. 17.58
Proptosis due to pleomorphic adenoma of the orbital lobe of the lacrimal gland

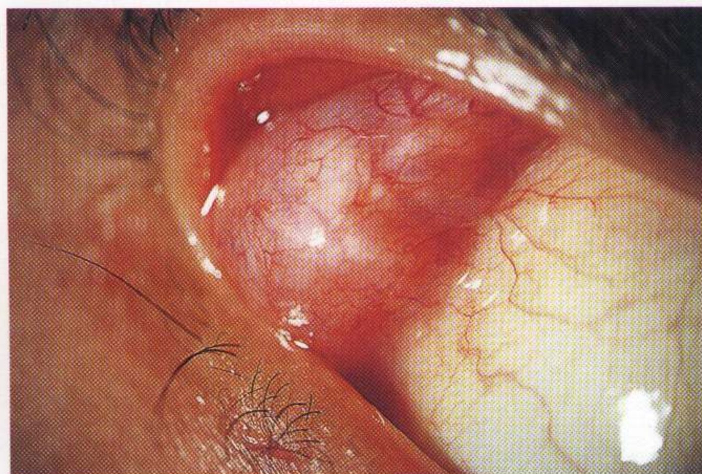


Fig. 17.59
Pleomorphic adenoma of the palpebral lobe of the lacrimal gland

- The less common tumour arising from the *palpebral lobe* tends to grow anteriorly, with upper lid swelling, and does not displace the globe (Fig. 17.59).

3. CT shows a round or oval mass, with a smooth outline with indentation but not destruction of the bone of the lacrimal gland fossa (Fig. 17.60). The lesion may also indent the globe.

Treatment

This involves surgical excision. If the diagnosis is strongly suspected, it is wise to avoid prior biopsy, to avoid tumour seeding into adjacent orbital tissue, although this may not always be possible in the context of diagnostic uncertainty. Tumours of the palpebral lobe are usually resected, along with a margin of normal tissue, through an anterior (trans-septal) orbitotomy. Those of the orbital portion are excised through a lateral orbitotomy as follows:

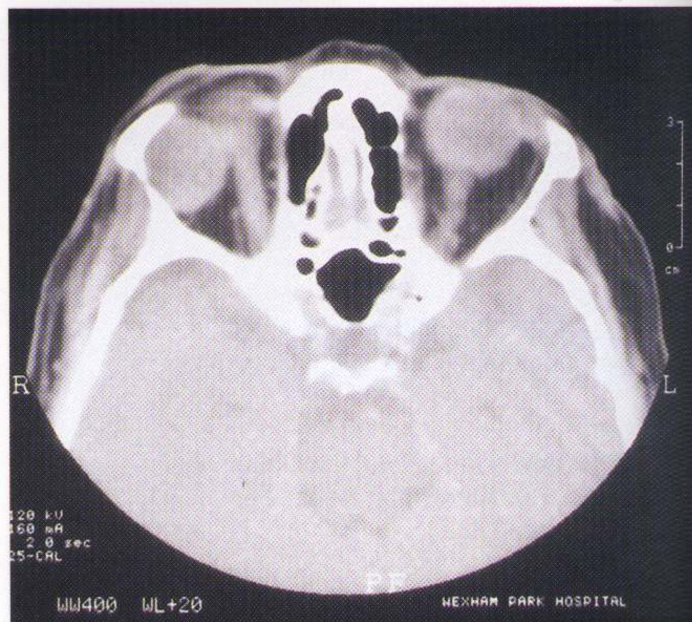


Fig. 17.60
Axial CT scan showing a right pleomorphic lacrimal gland adenoma with indentation of adjacent bone

a. The temporalis muscle is incised (Fig. 17.61a).
b. The underlying bone is drilled for subsequent wiring (Fig. 17.61b).
c. The lateral orbital wall is removed and the tumour excised (Fig. 17.61c).
d. The temporalis and periosteum are repaired (Fig. 17.61d).

The prognosis is excellent provided excision is complete and without disruption. Incomplete excision or preliminary incisional biopsy may result in seeding of the tumour into adjacent tissues, with recurrences which may later turn malignant.

Lacrimal gland carcinoma

Lacrimal gland carcinoma is a rare tumour which carries a high morbidity and mortality. In order of frequency the main histological types are: (a) *adenoid–cystic*, (b) *pleomorphic adenocarcinoma*, (c) *mucoepidermoid* and (d) *squamous cell*.

Clinical features

1. Presentation is in the fourth to sixth decades with a history shorter than that of a benign tumour. Pain, a feature of malignancy, may, however, also occur with inflammatory lesions. A pleomorphic adenocarcinoma (malignant mixed-cell tumour) may present in three main clinical settings:

- After incomplete or piecemeal excision of a benign pleomorphic adenoma, followed by one or more recurrences over a period of several years with eventual malignant transformation.
- As a long-standing proptosis (and/or a swollen upper lid) which suddenly starts to increase.

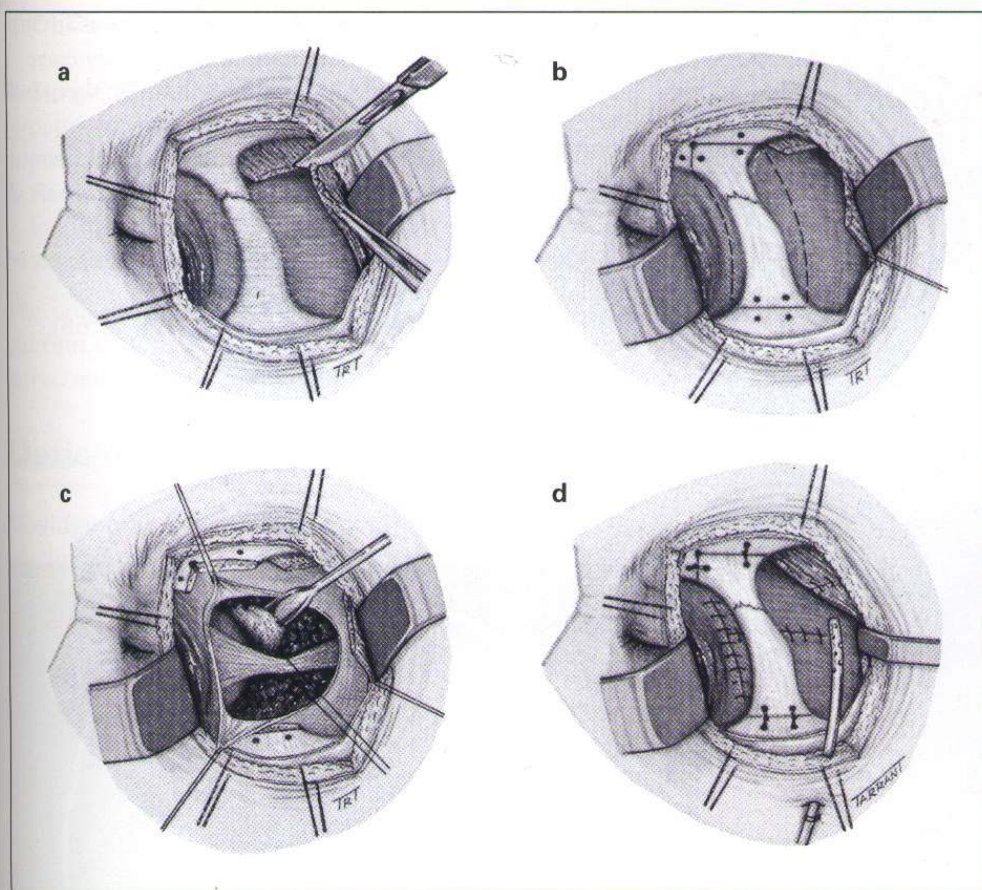


Fig. 17.61
Lateral orbitotomy (*see text*)

- Without a previous history of a pleomorphic adenoma as a rapidly growing lacrimal gland mass (usually of several months' duration).

2. Signs

- A mass in the lacrimal area with inferonasal dystopia (Fig. 17.62).
- Posterior extension, with involvement of the superior orbital fissure, may give rise to conjunctival and episcleral congestion and ophthalmoplegia (Fig. 17.63).
- Limitation of elevation and abduction is common.
- Hypoaesthesia in the region supplied by the lacrimal nerve.
- Optic disc swelling and choroidal folds.



Fig. 17.63
Periorbital oedema and congestion of the globe due to involvement of the superior orbital fissure by lacrimal gland carcinoma (Courtesy of G. Rose)



Fig. 17.62
Inferonasal dystopia and ptosis due to lacrimal gland carcinoma (Courtesy of G. Rose)

3. Investigations

a. CT shows contiguous erosion or invasion of bone. Calcification in the tumour is commonly seen.

b. Biopsy is necessary to establish the histological diagnosis. Subsequent management depends on the extent of tumour invasion of adjacent structures as seen on imaging studies.

c. Neurological assessment is mandatory because adenoid–cystic carcinoma, which spreads perineurally, may extend into the cavernous sinus.

Treatment

1. **Radical surgery**, in the form of orbital exenteration or mid-facial resection, may be attempted. Unfortunately the tumour is almost invariably past total surgical excision, with an extremely poor prognosis for life.
2. **Radiotherapy** combined with local resection may prolong life and reduce pain.

Optic nerve glioma

Optic nerve glioma is a slow-growing pilocytic astrocytoma, which typically affects young girls and occasionally adults. Neurofibromatosis-1 is a common association (*see* Chapter 20).

Clinical features

1. **Presentation** is often towards the end of the first decade with slowly progressive visual loss, followed later by proptosis (Fig. 17.64), although this sequence may occasionally be reversed.
2. **Signs**
   - Optic nerve dysfunction with visual impairment out of proportion to the degree of proptosis.
   - The optic nerve head, initially swollen (Fig. 17.65a), later becomes atrophic.
   - Opticociliary shunt vessels are occasionally seen (*see* Fig. 17.68).
   - Intracranial spread to the chiasm and hypothalamus may develop.
3. **Investigations**
   a. CT shows fusiform enlargement of the optic nerve (Fig. 17.65b).
   b. MRI may show intracranial extension (Fig. 17.66).

Management

This depends on whether the tumour manifests posterior extension.



Fig. 17.64
Severe proptosis due to optic nerve glioma (Courtesy of G. Rose)

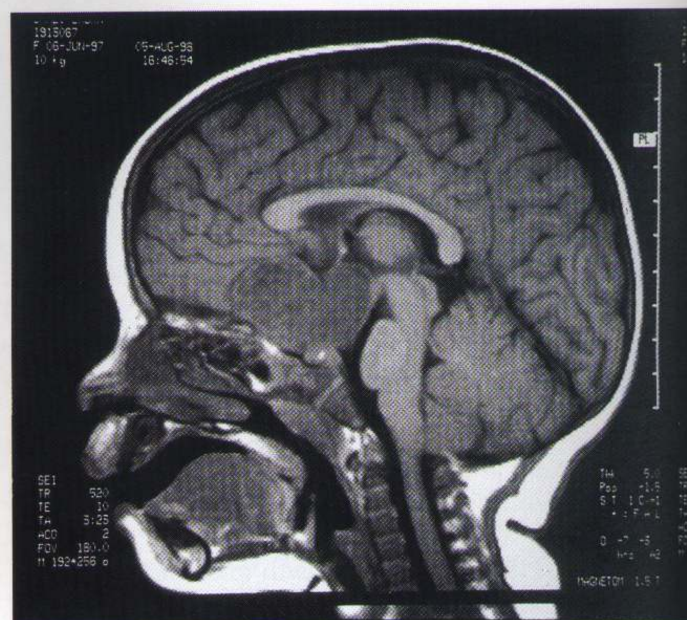


Fig. 17.66
Sagittal T1-weighted MRI scan showing invasion of the hypothalamus by an optic nerve glioma in NF-1 (Courtesy of D. Armstrong)

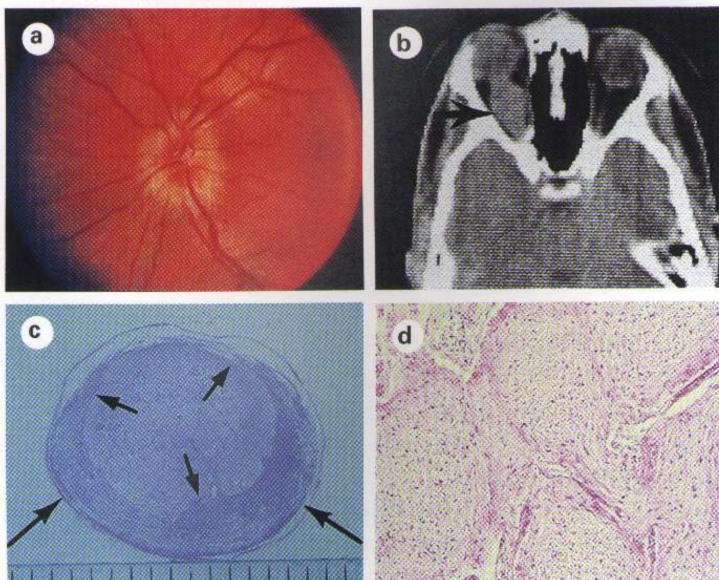


Fig. 17.65
Optic nerve glioma. (**a**) Disc oedema; (**b**) axial CT scan showing fusiform enlargement of the optic nerve; (**c**) short arrows outline the perimeter of the enlarged optic nerve and long arrows show thickening of the arachnoid sheath; (**d**) high-power section showing increased cellularity and generalized thickening of nerve fibre bundles (Courtesy of Wilmer Institute)

1. **Observation** in patients with no evidence of growth, good vision and no cosmetic deformity.
2. **Surgical excision** with preservation of the globe in patients with growing tumours, particularly if vision is poor and proptosis significant.
3. **Radiotherapy** may be combined with chemotherapy for tumours with intracranial extension that preclude surgical excision.

The prognosis for life is variable. Some tumours have an indolent course with little growth, while others may extend intracranially and threaten life.

Optic nerve sheath meningioma

Meningiomas arise from meningothelial cells of the arachnoid villi. Primary orbital meningiomas arising from the optic nerve sheath are, however, rare, representing about 2% of all meningiomas. They are less common than optic nerve gliomas and are more frequently encountered in females.

Clinical features

1. **Presentation** is in middle age with unilateral gradual visual impairment. Transient obscurations of vision may be the presenting symptom.
2. **Signs.** The classical triad is (a) *visual loss*, (b) *optic atrophy* and (c) *opticociliary shunt vessels*. However, the simultaneous occurrence of all three signs in one individual is uncommon. The sequence of involvement is as follows:

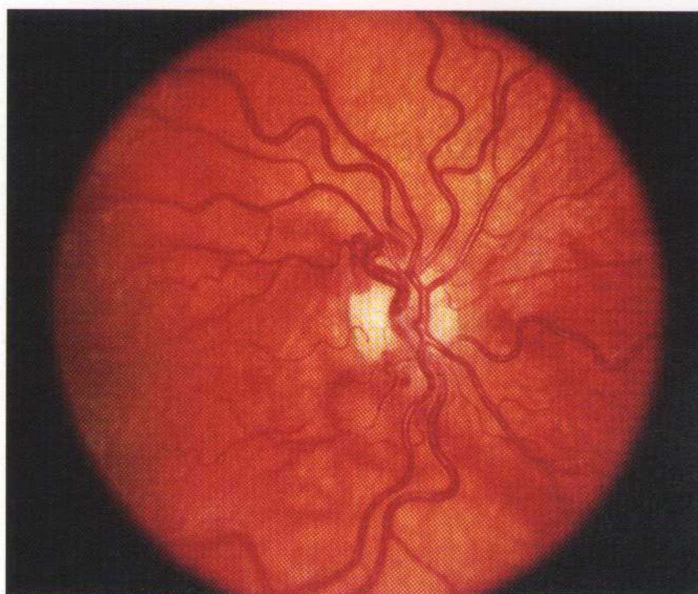


Fig. 17.68
Opticociliary shunts (Courtesy of C. Barry)

- Optic nerve dysfunction (Fig. 17.67b) and chronic disc swelling (Fig. 17.67a) followed by atrophy.
- Opticociliary shunt vessels (Fig. 17.68), found in about 30% of cases, regress as optic atrophy supervenes.
- Restrictive motility defects, particularly in upgaze, because the tumour may 'splint' the optic nerve (*see* Fig. 17.67c).
- Proptosis caused by intraconal spread usually develops after the onset of visual loss.

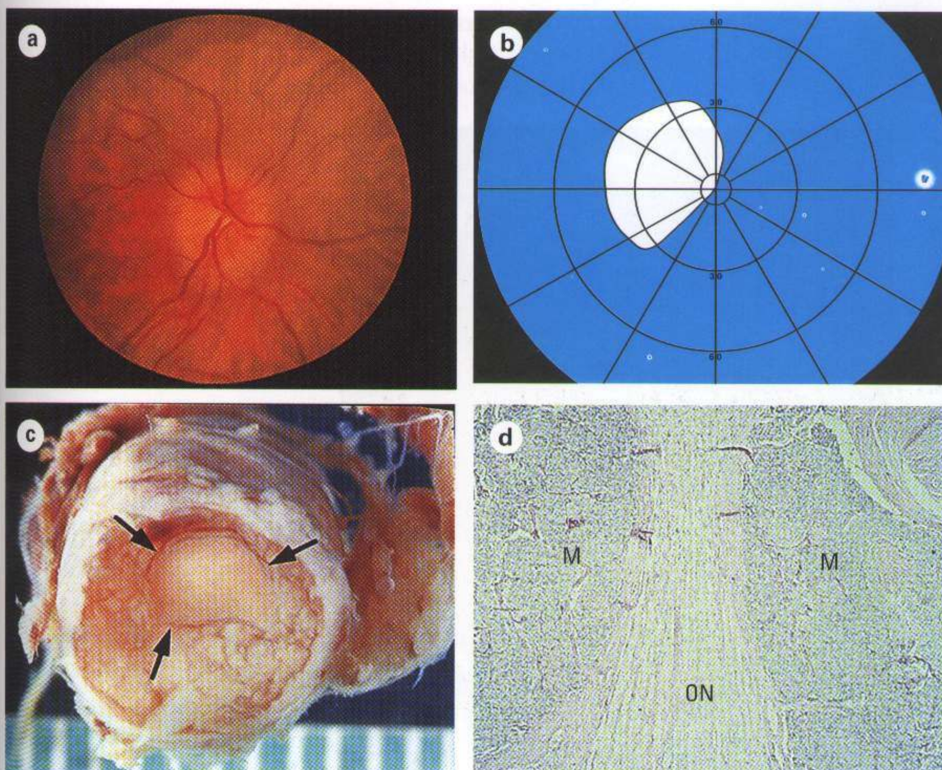


Fig. 17.67
Optic nerve sheath meningioma.
(**a**) Disc oedema; (**b**) visual field defect; (**c**) arrows outline the optic nerve surrounded by meningioma;
(**d**) high-power section showing the optic nerve (ON) and meningioma (M) (Courtesy of Wilmer Institute)

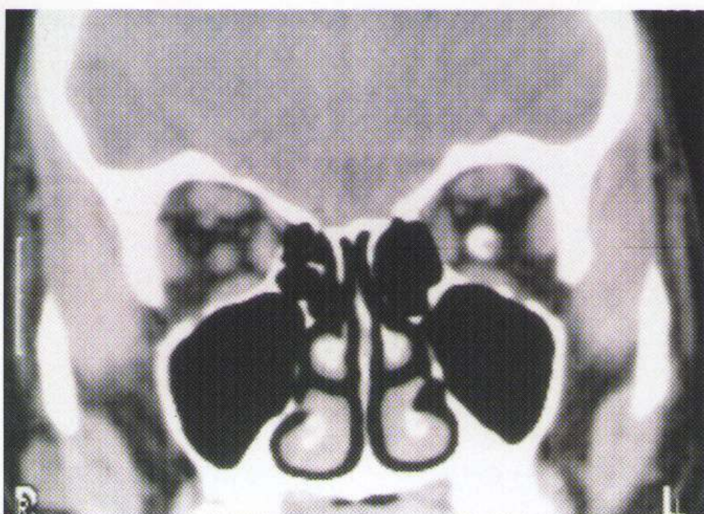


Fig. 17.69
Coronal CT scan showing thickening of the left optic nerve by an optic nerve sheath meningioma

> *NB:* This sequence is the opposite to that seen with tumours outside the dural sheath, in which proptosis develops long before optic nerve compression.

3. **CT** shows tubular thickening and calcification of the optic nerve (Fig. 17.69).

Management

1. **Observation** in middle-aged patients with slow-growing tumours because the prognosis is good.
2. **Surgical excision** in young patients with aggressive tumours, particularly if the eye is also blind.
3. **Radiotherapy** in selected cases.

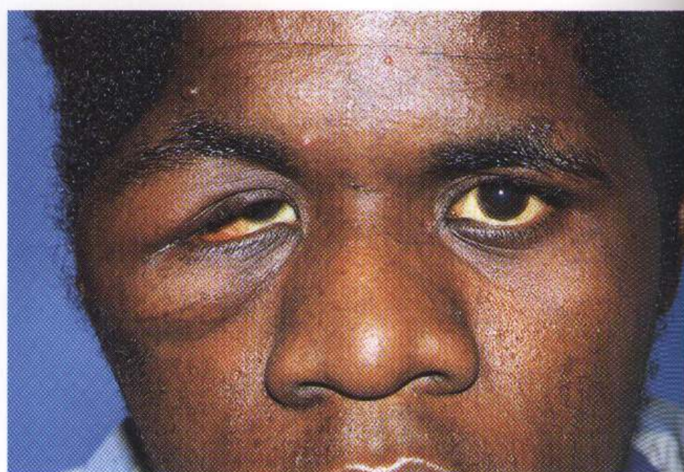


Fig. 17.70
Periocular involvement by plexiform neurofibroma

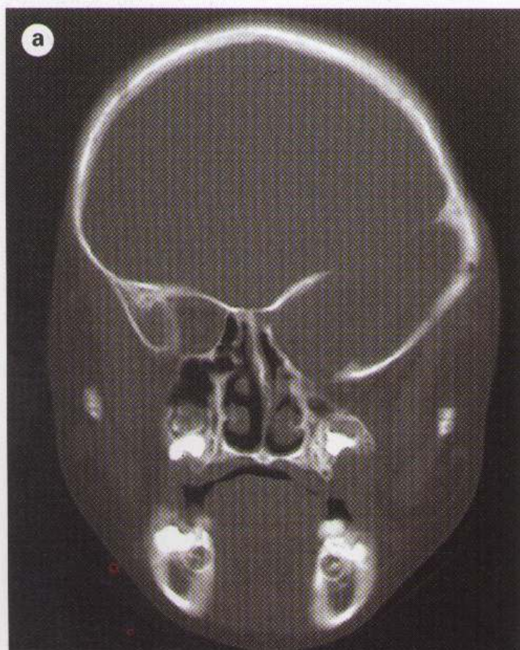
The prognosis for life is good in adults, although the tumour may be more aggressive and sometimes fatal in children.

Neurofibroma

Plexiform neurofibroma

Plexiform (diffuse) neurofibroma is the most common peripheral neural tumour of the orbit and occurs almost exclusively in association with neurofibromatosis-1 (*see* Chapter 20).

1. **Presentation** is in early childhood with periorbital swelling.
2. **Signs**
   - Diffuse involvement of the orbit with disfiguring hypertrophy of periocular tissues (Fig. 17.70).
   - Involvement of the eyelids causes mechanical ptosis with a characteristic S-shaped deformity. On palpation the involved tissues feel like a bag of worms.



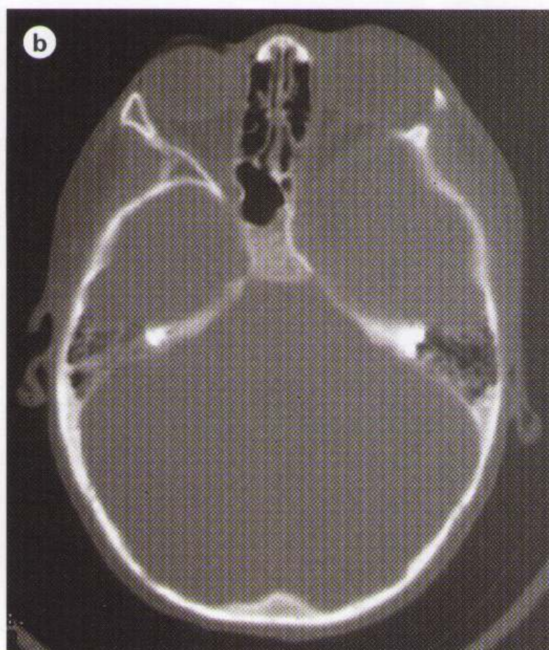


Fig. 17.71
CT scan showing absence of the greater wing of the left sphenoid bone. **(a)** Coronal view; **(b)** axial view (Courtesy of K. Nischal)

- Pulsation of the globe without a bruit (best detected on applanation tonometry) may be present if there is an associated congenital defect of the greater wing of the sphenoid bone (Fig. 17.71).

3. **Treatment** is extremely difficult. Surgery should be avoided if at all possible because of the intricate relationship between the tumour and important orbital structures.

Isolated neurofibroma

Isolated (localized) neurofibroma is less common and is associated with neurofibromatosis-1 in about 10% of cases.

1. **Presentation** is in the third to fourth decades with insidious mildly painful proptosis unassociated with visual impairment or ocular motility dysfunction.
2. **Treatment** by excision is usually straightforward because the tumour is well circumscribed and relatively avascular.

Lymphomas

Lymphomas of the ocular adnexa (i.e. conjunctiva, lacrimal gland and orbit) constitute approximately 8% of all extranodal lymphomas. They represent one end of the spectrum of lymphoproliferative lesions, at the other end of which lies benign reactive lymphoid hyperplasia. To further compound diagnostic difficulty, a 'grey zone' lies between the two poles of the spectrum in which accurate diagnosis cannot be established by conventional histological techniques.

Classification

The REAL (Revised European–American Lymphoma) classification subdivides lymphomas into five types, with progressive increase in the risk of extranodal disease at diagnosis, of dissemination with time, and of tumour-related death.

- Extranodal marginal-zone B-cell lymphoma.
- Follicle centre lymphoma.
- Diffuse large B-cell lymphoma.
- Plasmacytoma.
- Lymphoplasmocytic lymphoma.

Clinical features

1. **Presentation** is insidious and usually in the sixth to eighth decades.
2. **Signs**
   - Any part of the orbit may be affected, and occasionally involvement is bilateral (Fig. 17.72).
   - Anterior lesions may be palpated and have a rubbery consistency (Fig. 17.73).
   - Occasionally the lymphoma may be confined to the conjunctiva or lacrimal glands, sparing the orbit.
3. **Systemic investigations** in patients with hypercellular lymphoid lesions of the orbit include chest radiographs, serum immunoprotein electrophoresis, thoraco-abdominal CT to detect possible retroperitoneal involvement and, if necessary, bone marrow aspiration.
4. **Course**. This is variable and may be unpredictable. In some patients histological features raise suspicion of malignancy and yet the lesion resolves spontaneously or with the help of steroids. Conversely, what appears to be a benign lymphoid hyperplasia may be followed several years later by the development of lymphoma. Treatment involves radiotherapy for localized lesions and chemotherapy for disseminated disease.



Fig. 17.72
Bilateral orbital lymphoma

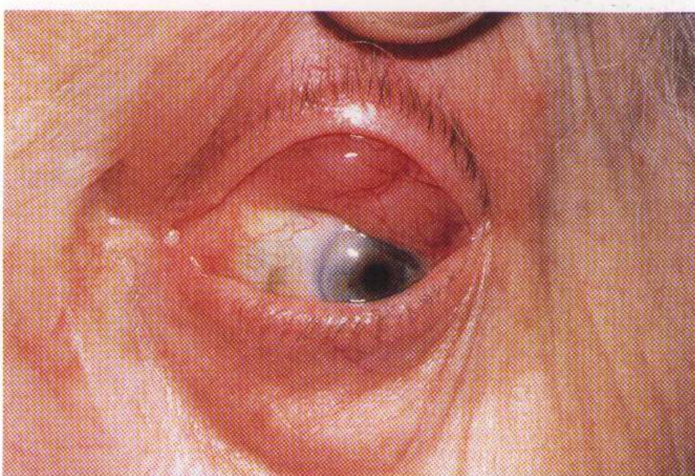


Fig. 17.73
Anterior orbital lymphoma

Rhabdomyosarcoma

Rhabdomyosarcoma is the most common childhood primary orbital malignancy. The main role of the ophthalmologist is confined to diagnosis by incisional biopsy followed by prompt referral to a paediatric oncologist.

Clinical features

1. **Presentation** is in the first decade (average 7 years) with rapidly progressive proptosis which may initially mimic an inflammatory process.

2. **Signs**
   - The tumour is most frequently retrobulbar, followed by superior and inferior (Fig. 17.74).
   - A palpable mass and ptosis are present in about one-third of cases (Fig. 17.75).
   - Swelling and injection of overlying skin develop later but the skin is not warm (Fig. 17.76).
   - Parameningeal tumours show bony destruction, lymph node dissemination and involvement of the CNS.
3. **CT** shows a poorly defined mass of homogeneous density often with adjacent bony destruction (Fig. 17.77). In advanced cases tumour spread into the paranasal sinuses may be seen.



Fig. 17.74
Rhabdomyosarcoma (Courtesy of D. Taylor)



Fig. 17.75
Rhabdomyosarcoma (Courtesy of D. Taylor)



Fig. 17.76
Erythema and vascular engorgement of the eyelid associated with rhabdomyosarcoma (Courtesy of M. Szreter)

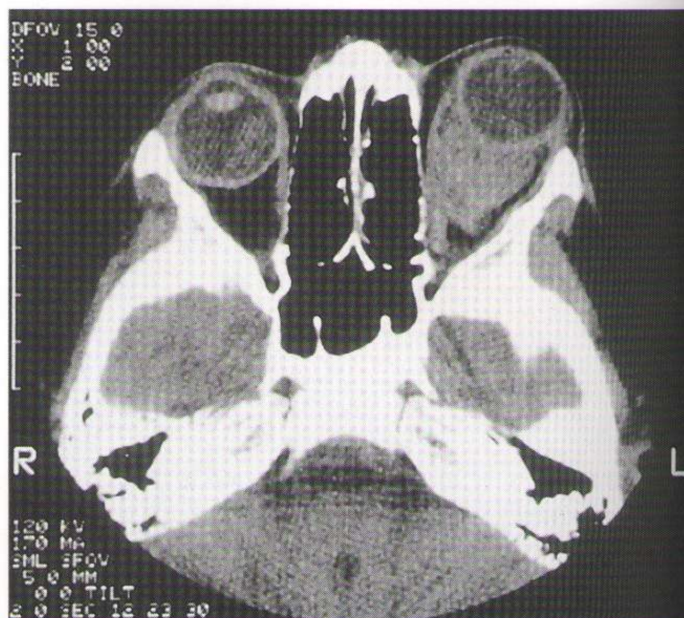


Fig. 17.77
Axial CT scan of a left rhabdomyosarcoma (Courtesy of K. Nischal)

4. **Systemic investigations** for evidence of metastatic spread include chest X-ray, liver function tests, bone marrow biopsy, lumbar puncture and skeletal survey. The most common sites for metastases are lung and bone.

Treatment

1. **Radiotherapy** followed by **chemotherapy** with vincristine, actinomycin and cyclophosphamide.
2. **Surgical excision** is reserved for the rare recurrent or radio-resistant tumour.

The prognosis is dependent on the stage and location of disease at the time of diagnosis. Patients with tumours localized to the orbit have a 95% cure rate.

Differential diagnosis

1. **Orbital cellulitis** typically presents in children with similar acute signs although in rhabdomyosarcoma the skin is not warm.
2. **Granulocytic sarcoma** may also present similarly with a rapidly growing orbital mass (*see* below).

Childhood metastatic tumours

Neuroblastoma

This is one of the most common childhood malignancies. It arises from primitive neuroblasts of the sympathetic chain, most commonly in the abdomen, followed by the thorax and pelvis. Presentation is usually in early childhood; in almost half the cases the tumour is disseminated at diagnosis with


Fig. 17.78
Metastatic neuroblastoma (Courtesy of K. Nischal)

an appalling prognosis. Orbital metastases may be bilateral and typically present with an abrupt onset of proptosis accompanied by a superior orbital mass and lid ecchymosis (Fig. 17.78).

Granulocytic sarcoma (chloroma)

This is a localized tumour composed of malignant cells of myeloid origin. Because the tumour can exhibit a characteristic green colour it was formerly referred to as chloroma. Granulocytic sarcoma may occur as a manifestation of established myeloid leukaemia or it may precede the disease. Presentation is most frequently at about age 7 years with rapid onset of proptosis, sometimes bilateral, which may be associated with ecchymosis and lid oedema (Fig. 17.79). When orbital involvement precedes systemic leukaemia the diagnosis may be difficult.

Langerhans cell histiocytosis (granulomatosis)

This is a rare, poorly understood, multi-system disease characterized by destructive inflammatory lesions that primarily involve bone. Soft tissues are less commonly involved, but cutaneous and visceral involvement may occur. Patients with solitary lesions (eosinophilic granuloma) have a benign course and respond well to treatment. Orbital involvement consists of unilateral or bilateral osteolytic lesions and soft tissue involvement, typically in the superotemporal quadrant (Fig. 17.80).


Fig. 17.79
Advanced granulocytic sarcoma (Courtesy of P. Morse)


Fig. 17.80
Left inferior dystopia due to Langerhans-cell histiocytosis (Courtesy of D. Taylor)

Adult metastatic tumours

Orbital metastases are an infrequent cause of adult proptosis and are much less common than metastases to the choroid. If the orbit is the initial manifestation of the tumour, the ophthalmologist may be the first person to see the patient. In order of frequency the most common primary sites are breast, bronchus, prostate, skin melanoma, gastrointestinal tract and kidney.

1. Presentation
- A mass in the anterior orbit causing dystopia or proptosis is the most common (Fig. 17.81).
- Infiltration of orbital tissues characterized by ptosis, diplopia, brawny indurated periorbital skin and a firm orbit, characterized by resistance to manual retropulsion of the globe.
- Enophthalmos with schirrous tumours.
- Chronic orbital inflammation.
- Primarily with involvement of the cranial nerves (II, III, IV, V, VI) at the orbital apex and only mild proptosis.

2. Special investigations
   *a. **Fine-needle biopsy*** under CT control is useful for histological confirmation. If this fails, open biopsy may be required.


Fig. 17.81
Right non-axial proptosis due to metastatic hypernephroma

b. Hormonal studies on tissue specimens may be used to guide specific hormone therapy in responsive tumours.

3. **Treatment** is aimed at preserving vision and relieving pain because most patients die within 1 year. Radiotherapy is the mainstay of treatment. Orbital exenteration rarely may be required if other modalities fail to control intolerable symptoms.

Orbital invasion by sinus tumours

Malignant tumours of the paranasal sinuses, although rare, may invade the orbit and carry a poor prognosis unless diagnosed early. It is therefore important to be aware of both their otolaryngological and ophthalmic features.

1. **Maxillary carcinoma** is by far the most common sinus tumour to invade the orbit.
   a. Otolaryngological manifestations include facial pain, congestion and swelling (Fig. 17.82), epistaxis and nasal discharge.
   b. Ophthalmic features include upward dystopia (Fig. 17.83), diplopia and epiphora.
2. **Ethmoidal carcinoma** may cause lateral dystopia.
3. **Nasopharyngeal carcinoma** may spread to the orbit through the inferior orbital fissure. Proptosis is a late finding.

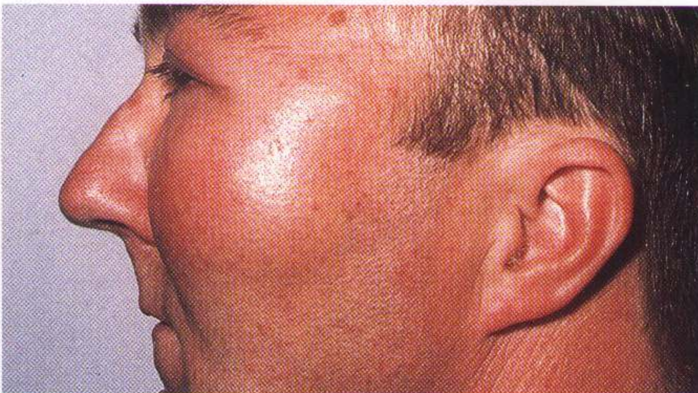


Fig. 17.82
Swelling of the face in advanced carcinoma of the maxillary antrum



Fig. 17.83
Left upward dystopia in carcinoma of the maxillary antrum
(Courtesy of G. Rose)

Craniosynostoses

Craniosynostoses are a group of rare hereditary disorders characterized by premature fusion of cranial sutures accompanied by severe orbital abnormalities. The two most common entities are: (a) *Crouzon syndrome* and (b) *Apert syndrome.*

Crouzon syndrome

Crouzon syndrome is caused primarily by premature fusion of the coronal and saggital sutures. Inheritance is AD, but 25% of cases represent a fresh mutation.

1. **Ocular features**
   - Proptosis due to shallow orbits is the most conspicuous feature (Fig. 17.84). The shallowing is secondary to arrested growth of the maxilla and zygoma. In extreme cases the globes may become luxated anterior to the eyelids.
   - Hypertelorism (wide separation of the orbits).
   - V pattern exotropia and hypertropia.
   - Vision-threatening complications include exposure keratopathy and optic atrophy, due to compression at the optic foramen.
2. **Ocular associations** include aniridia, blue sclera, cataract, ectopia lentis, glaucoma, coloboma, megalocornea and optic nerve hypoplasia.
3. **Systemic features**
   - Short anteroposterior head distance and wide cranium due to premature fusion.
   - Midfacial hypoplasia and curved 'parrot-beak' nose which gives rise to a 'frog-like' facies.
   - Mandibular prognathism.
   - Inverted V-shaped palate.
   - Acanthosis nigricans.

Apert syndrome

Apert syndrome (acrocephalosyndactyly) is the most severe of the craniosynostoses and may involve all the cranial sutures. Inheritance is autosomal dominant, but the majority of cases are sporadic and are associated with older parental age.



Fig. 17.84
Crouzon syndrome



Fig. 17.85
Apert syndrome

1. **Ocular features**
   - Shallow orbits, proptosis and hypertelorism are generally less pronounced than in Crouzon syndrome (Fig. 17.85).
   - Exotropia.
   - Antimongoloid slant of the palpebral apertures.
   - Vision-threatening complications include corneal exposure and optic atrophy.
2. **Ocular associations** include keratoconus, ectopia lentis and congenital glaucoma.
3. **Systemic features**
   - Oxycephaly with flattened occiput and steep forehead.
   - Horizontal groove above the supraorbital ridge.
   - Midfacial hypoplasia with a 'parrot-beak' nose and low-set ears.
   - High-arched palate, cleft palate and bifid uvula.
   - Syndactyly of the hands and feet.
   - Anomalies of the heart, lungs and kidneys.
   - Acneiform skin eruptions on the trunk and extremities.
   - Mental handicap in 30% of cases.